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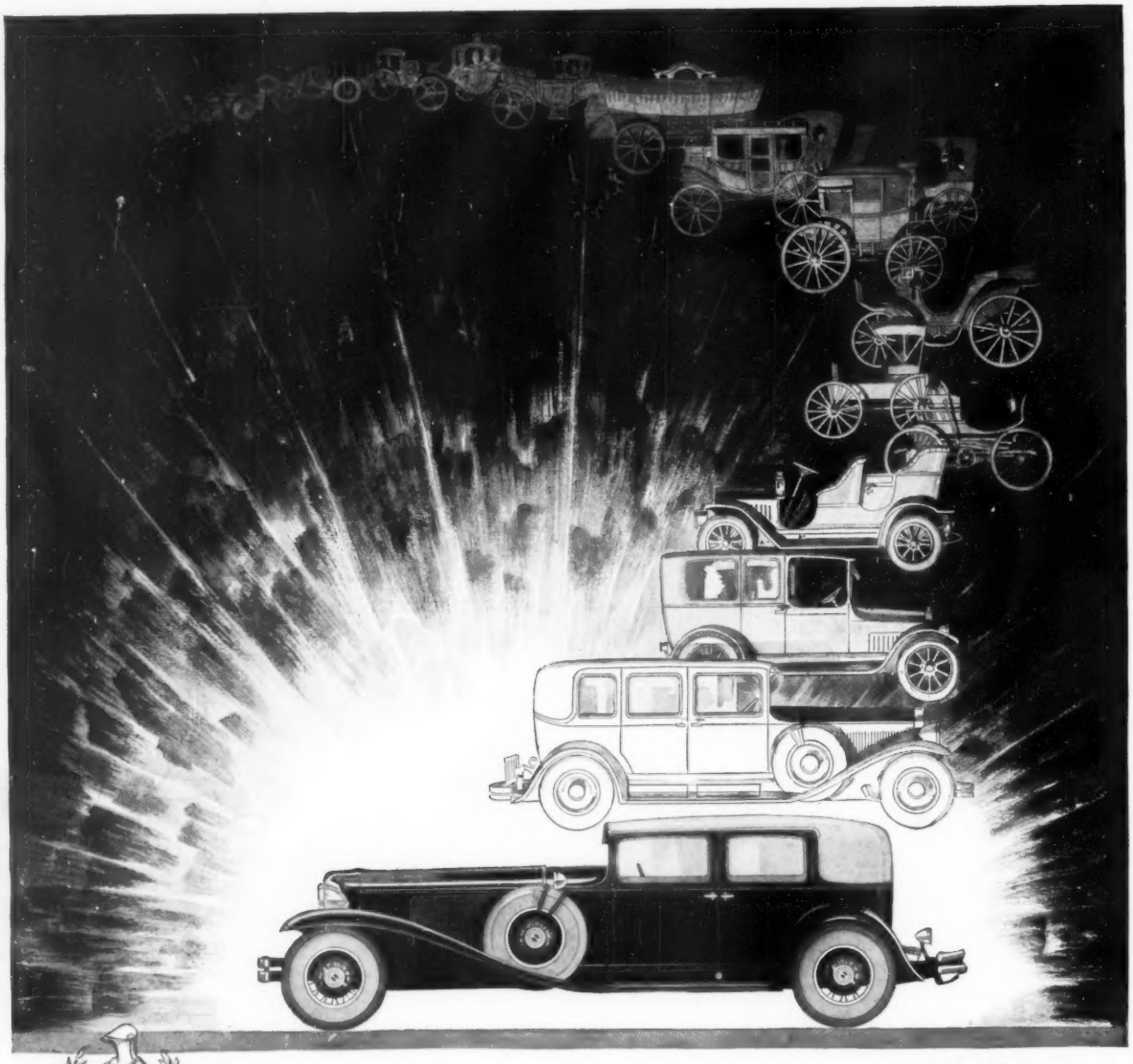

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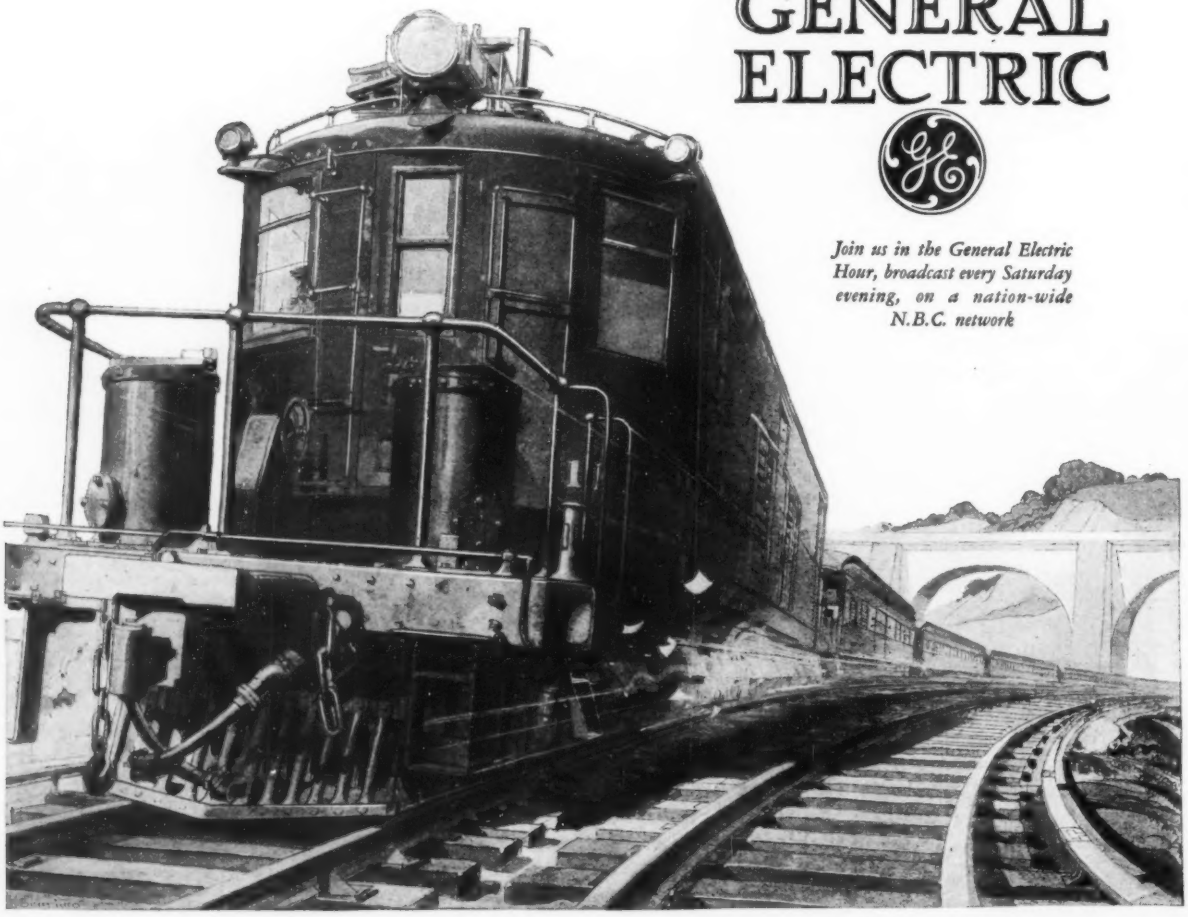

SCIENTIFIC AMERICAN

July 1930 — *ORSON D. MUNN, Editor* — *Eighty-sixth Year*

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COVER

A new sport combining two modern devices—the glider and the outboard motor—has been introduced in California and bids fair to become widely popular. Our artist, Howard V. Brown, has painted for our cover this month a vivid presentation of this sport. In the article on page 37 will be found a description of the "flying outboard motorboat," telling how it flies and something of the thrills that may be expected from it.

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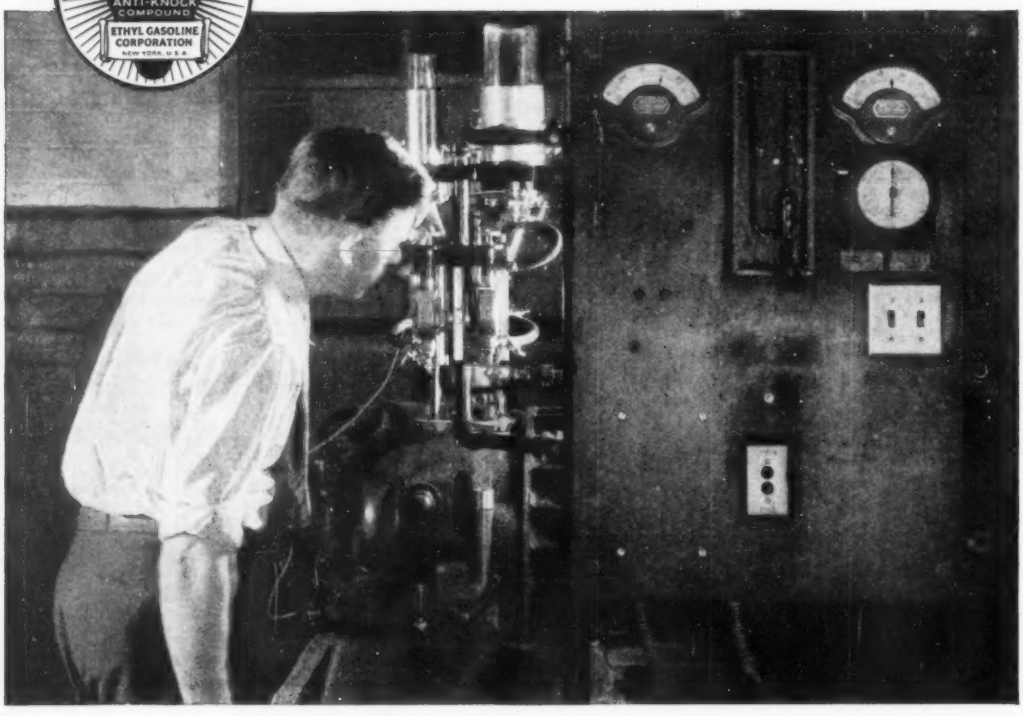
Why Ethyl is more than "good gasoline"



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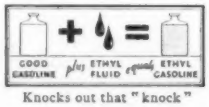

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Looking Ahead *With the* Editor

Walking on Water

OF all the insect life we see on a summer's day in the country, the water skippers walking and dancing around on the surface of the water hold our interest and puzzle us. How do they do it? We study their actions and discover—but wait! The secret of how they walk on water, and certain other interesting things in connection with this accomplishment, as shown by careful experiment, will be told in a forthcoming article.

"Basic Patents" in Evolution

AN article ready for release draws an illuminating comparison between airships and the human body to illustrate evolution from "basic patents." But when the intricate engines of the human body were being tried out in nature's testing ground, no patent records were kept. This article, however, will review the evolution of human locomotor apparatus insofar as generations of men of science have been able to piece it together from "basic patents" by comparative methods.

Fingerprinting Diamonds

IT is not always easy to identify diamonds even by their flaws—and 96 percent of those mined are imperfect—but it has always been difficult positively to identify perfect stones—the other 4 percent. A new photomicrographic method of "fingerprinting" all gems, however, is as positive as the Bertillon system. This method will be fully described in these pages soon.

Burying a River

A RELATIVELY insignificant river that flows through residential sections of St. Louis presented a major problem. In times of flood, it rose to many times its normal proportions, flooded houses and factories, and caused great losses. How the problem was solved by burying the river in the world's largest sewer, and some of the engineering feats necessary on that job will be described in an article soon to come.

Forest Fires

THOUGHTLESSNESS, more than any other thing, caused the destructive forest fires that raged in the east last spring. It almost seems that people cannot be cured of their thoughtlessness but we must continue the effort. Your aid is enlisted. Read the coming article that deals with forest fires, the destruction they cause, the great expense of protection, and methods of prevention, and give your friends the startling facts.

Every Issue Fully Illustrated

¶ *The well-informed man or woman is the one who progresses. Why not let the* SCIENTIFIC AMERICAN *bring to you the latest news of the scientific world in general? The cost is nominal—only four dollars for an entire year's subscription.*

Among Our Contributors

M. R. Harrington

CURATOR of the Southwest Museum in Los Angeles, Mr. Harrington has made some important explorations and discoveries. He explored eastern Cuba and discovered that two distinct pre-Columbian peoples inhabited it in succession. He discovered the bluff-dweller culture of the Ozarks; explored Lovelock Cave in Nevada and discovered an ancient basketmaker culture; explored and interpreted Lost City; and explored Gypsum Cave. He has visited, lived, and worked with 33 tribes of North American Indians.

George P. Thomson

PROFESSOR THOMSON, of the Scottish University at Aberdeen, is the son of the noted Sir J. J. Thomson, discoverer of the electron. When he made the now famous experiment described in the article we publish, a great physicist told one of the editors that he "was not at all surprised," that he expected "the brilliant son to reach soon the same heights of attainment as his father."

Charles L. Lawrance

WHO, among the millions that thrilled at the news of Lindbergh's transatlantic flight, has not heard of Mr. Lawrance? He it was who designed the famous Wright Whirlwind engine, which powered the *Spirit of St. Louis* as well as other famous planes. Mr. Lawrance is Vice President of the Curtiss-Wright Corporation in charge of engineering. He has been a leader in the flying club movement and is the President of the successful Long Island Aviation Country Club.

George W. Crile

THE work of Dr. Crile, if fully listed and discussed, would fill volumes. He is one of the founders and the Director of the Cleveland Clinic. He has degrees from Vienna, Paris, London, and Dublin; honors, medals, and memberships in scientific and medical associations from many countries; and is a Chevalier of the Legion of Honor. The co-authors of his article, Maria Telkes and Amy F. Rowland, were trained in biophysics, the former in the University of Budapest, the latter at Mount Holyoke.

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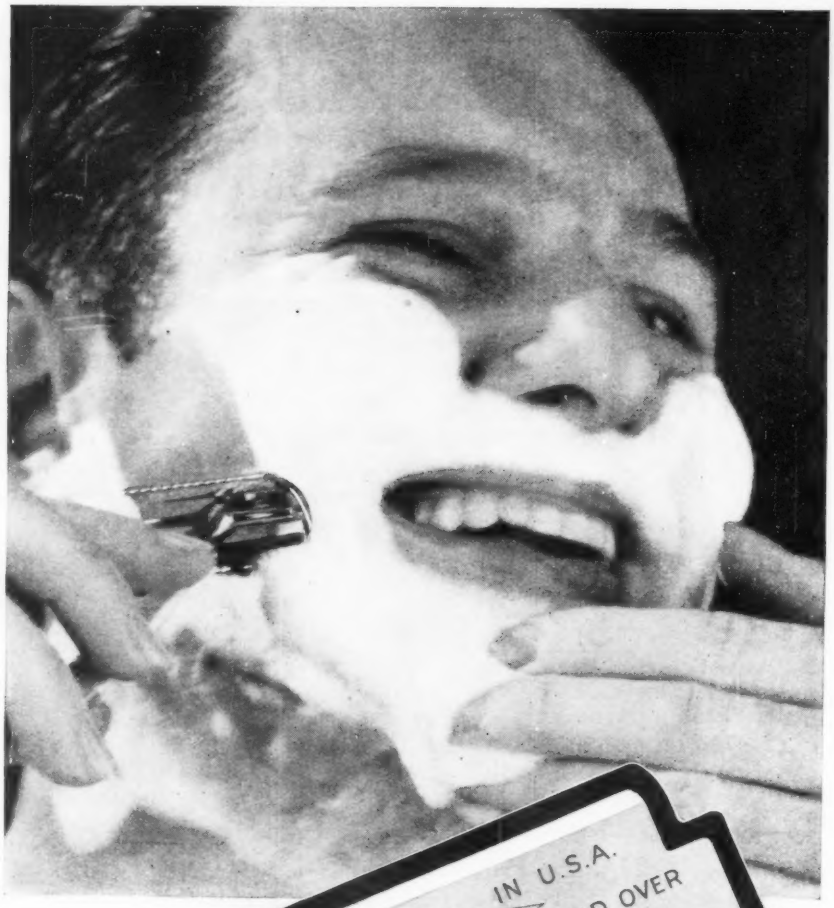

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C. J. Davisson L. H. Germer

DOCTORS Davisson and Germer of the Bell Telephone Laboratories in New York performed experiments which furnished physics with concrete evidence that De Broglie and Schrödinger were right when they attributed a wave nature to the electron, hitherto regarded as a wholly material particle. The wave atom concept, explained on page 38, is now rapidly displacing the more familiar Bohr atom having analogy with sun and planets. This recent trend is likely to discomfit writers of popular science whose books have tended to create the unfortunate impression that the facts at last have been finally settled, instead of being constantly subject to revision in the light of new experimental evidence, as they actually are among physicists, and as they should be. Further discomfiture is in store for all who attempt to popularize the wave atom concept, for it has no cut-and-dried, familiar analogy like sun and planets and, strictly speaking, can be expressed only in the most agonizing of higher mathematics. Hence the planetary atom is likely to remain in style, popularly, some years after most physicists have discarded it. In the photograph Dr. Davisson holds in his hands the glass evacuated tube into which was sealed the same small apparatus shown on page 40. Dr. Davisson came to science via the University of Chicago and Princeton; Dr. Germer via Cornell and Columbia. They are typical examples of workers in pure science.

Clearing the Interior of a Pyramid

THE important excavations conducted by the Museum of the University of Pennsylvania at Meydum pyramid in Egypt are fully described in the article starting on the opposite page. A casing of well-cut limestone blocks completed the pyramid. On the slant of the pyramid this masonry outcrops from the debris and an opening in the casing gives access to the interior. A man is posted in the entrance who hands out the broken material passed up through the long passage by a chain of 60 men. All the loose material, earth, et cetera, is carefully sifted to see if it contains valuable material. The sifter in our photograph shows great inventiveness, for Egypt. The "boy" has attached a sieve to a post, thus taking up weight.

All photographs courtesy Museum of the University of Pennsylvania

The Meydum pyramid of today, as reduced from the original form, showing the southern side. This illustrates the condition of the pyramid before last season's work began

Exploring the Meydum Pyramid Site

By Cornelia H. Dam

Staff, Museum of the University of Pennsylvania

IN the age of Tutankhamen and of Rameses the Great, 1500 years before Christ, the Pharaohs of Egypt, whose empire extended from the heart of Nubia to the Mediterranean and included Libya, Sinai, Syria, and Palestine, used to boast of their exploits that "nothing like it had been done since the time of Seneferu." This venerable name, which echoes through Egyptian records for two thousand years, designates the first really great historic king of Egypt, father of that Cheops (Khufu) who built the great pyramid of Gizeh, near Cairo.

WITH Seneferu, who died about 2900 B.C., we are at last on firm ground in Egyptian history. He laid the foundations for the Fourth Dynasty, that remote, magnificent period of which the art was never again equaled, and of which the great pyramids of Cheops, Chephren, and Mycerinus are the immortal monuments. From later records, notably the Palermo Stone, we know something of his exploits: he united Egypt under his rule from Nubia to the Mediterranean, and invaded Libya, returning with 7000 prisoners; he sent a fleet of 40 vessels to the northern coast of Syria for cedar logs, and expeditions across the desert into the Sinai mountains for copper, so consistently that he was later regarded as the founder of Egyptian operations there, and stations on the desert route thither bore his name for 2000 years. He caused to be built vessels 175 feet long for his traffic on the Nile.

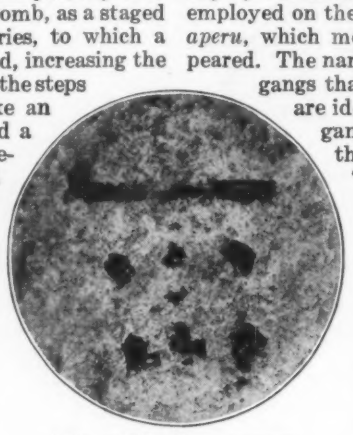
The marvels of his reign and the splendor of his court are referred to again and again in later records—the Westcar papyrus relates how the king, suffering from ennui, was taken to row upon a lake, with a gay party of youths and maidens, and all went well until one of the girls dropped a favorite malachite pendant overboard. But a court magician saved the day by piling up the waters of the lake, as Moses did the Red Sea, and recovered the jewel.

A long passage sloping downward leads to the tomb of a Pharaoh in the pyramid

At Meydum, about 50 miles south of Cairo, where the western desert edge touches the fertile floor of the Nile valley, Seneferu built the earliest known true pyramid, for the two similar earlier constructions at Sakkara and at Zawiet el Aryan seem never to have had added the outer casing which would have turned their stepped stages into a true pyramid form. And at Meydum, time and weather, and above all the depredations of man, have destroyed most of the casing and exposed the stages and the rubble core of its construction, so that today the pyramid presents a stepped appearance, not unlike the staged towers of Babylonia, and has therefore often been called a "false pyramid." Excavations, however, have revealed the original casing blocks on the lower stages, and the methods of construction, which are of considerable interest for the history of the development of architecture.

The pyramid seems to have been

built cumulatively, quite possibly over an original mastabah tomb, as a staged building of seven stories, to which a later coating was added, increasing the stories to eight; finally the steps were filled in to make an even inward slope, and a casing of well-cut limestone blocks, quarried far away across the Nile, and floated over during the inundation, completed it. The original height of the pyramid has been estimated as about 300 feet; the existing stages rise only 214, but it is still an imposing pile, visible from many miles around.



"Six cubits," a quarrymen's mark in black paint on a stone of the pyramid

The cumulative construction evident in this earliest true pyramid is particularly interesting for the light it throws on the probable development of that architectural form from a mastabah, because the next pyramid in date, that of Cheops at Gizeh, was obviously planned in its finished form from the beginning. We might say that Seneferu *invented* the pyramid!

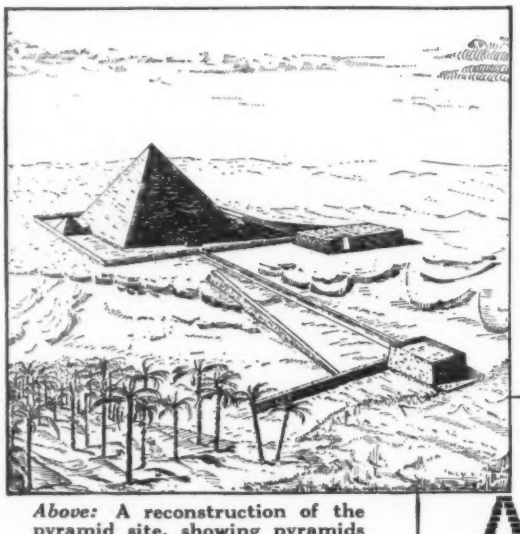
Three great Egyptologists, Mariette, Maspero, and Petrie, had each done work at Meydum before the Museum of the University of Pennsylvania undertook excavations there last November. But the site had never been thoroughly explored, and it was with reasonable, and soon justified, hopes of important finds that Mr. Alan Rowe took the field as director of the expedition.

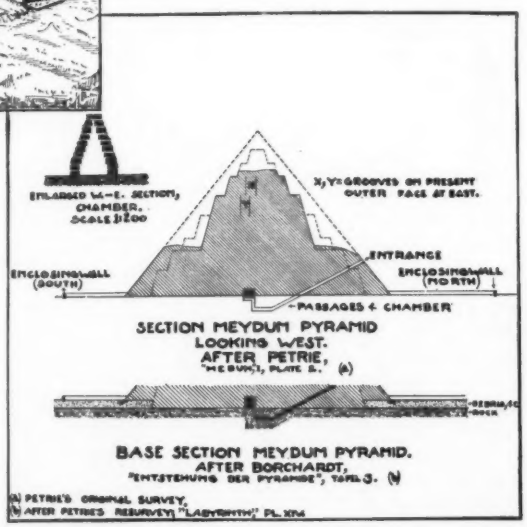
The first work undertaken was on the pyramid itself, removing the centuries' accumulation of debris and rubbish from its base, and clearing the passages and chambers in the interior. It was a long and laborious task, involving the removal of hundreds of tons of debris, and the labor of a large party of workmen for the greater part of the season.

ON fragments of stone found in the debris around the base were painted inscriptions giving the dates of the 16th or of the 17th year of the king's reign, apparently the year in which the casing was put on, and the pyramid completed. These marks were put on the blocks in the quarry, before they were transported across the valley and presumably for the purpose of making a count of the number cut each day by the different gangs of workmen employed on the operation. The word *aperu*, which means "gang," also appeared. The names of a number of the gangs that worked at Meydum are identified: the "pyramid gang," the "north-gang," the "enduring-gang," the "vigorous-gang," and the "scepter-gang." Lines in red paint, the original levelling lines of the builders, and their measurements in cubits also appear on the stones still in situ on the pyramid.

The task of clearing away the debris outside is not yet completed, but the interior was finished in time for the visit of the king and queen of the Belgians on March 30. The entrance to the pyramid, once carefully concealed, is some 60 feet from the ground on the north side, thence a long narrow passage, less than six feet high, descends for 185 feet to an antechamber, about twice as wide as the passage, on its left, and another immediately following on its right. Thence a horizontal passage leads to the shaft which opens into the sepulchral chamber some 20 feet overhead. It is a tiny room, about 20 feet long and high, but only nine feet wide, with stone walls and floor, and a steeply corbelled ceiling.

To clear the interior a long chain of men, increasing as they worked inward to the number of 90, was formed to pass in empty baskets and pass them out full, for in the narrow passage only one man at a time could work with pick and hoe. "It is a long and tedious job," wrote Mr. Rowe, in his monthly report to the Museum, "as the farther we penetrate the worse the air becomes. In fact when we had reached the bottom of the sloping passage leading from the outer entrance, just at the point where the passage runs into an antechamber, we were able to work for only one hour each day. At the end of this time our candles went out, warning us that it was unsafe to remain inside any longer." Nothing of very great importance was found inside the pyramid, as it had been opened and robbed in antiquity—how soon after it had been sealed up we cannot say, certainly it was open in the Twentieth Dynasty (c. 1200 B.C.), for the names of two scribes who visited it then are still visible on the ceiling of the passage. "Fools' names" are often valuable evidence in archeology!



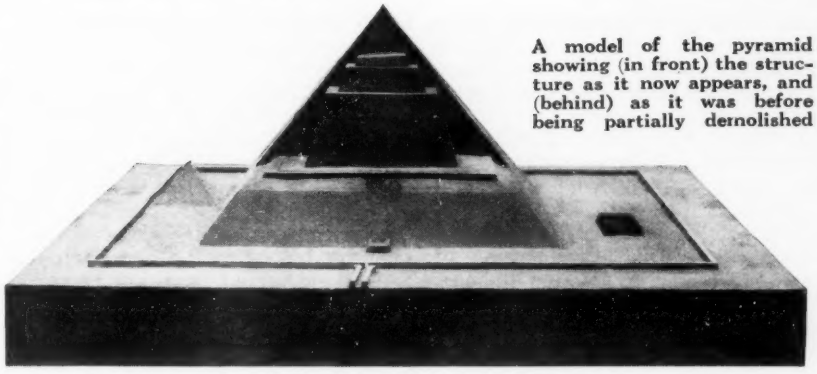

ENLARGED W.-E. SECTION, CHAMBER. SCALE 1:100
X, Y: GROOVES ON PRESENT OUTER FACE OF EAST.
ENTRANCE
ENCLOSING WALL (SOUTH)
ENCLOSING WALL (NORTH)
PASSAGES & CHAMBER
SECTION MEYDUM PYRAMID LOOKING WEST. AFTER PETRIE, "MEDUM", PLATE 5. (A)
BASE SECTION MEYDUM PYRAMID. AFTER BORCHARDT, "ENTSTEHUNG DER PYRAMIDE", TAFEL 3. (B)
(A) PETRIE'S ORIGINAL SURVEY.
(B) AFTER PETRIE'S RESURVEY, "LABYRINTH", PL. XIV.

Above: A reconstruction of the pyramid site, showing pyramids and adjacent structures. *At the right:* Sections of the pyramid

AGAINST the east face of the pyramid is a small temple, consisting of a vestibule and a little rectangular room, behind which, in a courtyard, stand two uninscribed stelae with an offering table between them. On the walls are pictures and scribblings put there by visitors to the sacred precincts 3500 years ago. One scribe of the time of Thothmes I. (c. 1500 B.C.), wrote on the wall that he "came here to see the beautiful temple of the Horus (king) Seneferu: he found it like heaven within when the sun-god is rising in it: and he exclaimed 'the heaven rains with fresh frankincense and drops incense upon the roof of the temple of the Horus Seneferu.' "

From the valley edge (the inundation level), where by analogy with other pyramid sites there should be a small

entrance temple, although none has yet been found, there runs a long brick-faced causeway, by which pilgrims in ancient days might approach the sacred pyramid area, which was surrounded by a wall, and enter it by a gate at the end of the causeway, directly opposite the entrance to the temple. To the south of this causeway are the remains of another, which was evidently used as a road to haul material during the construction of the pyramid, then partly destroyed and covered over.



A model of the pyramid showing (in front) the structure as it now appears, and (behind) as it was before being partially demolished

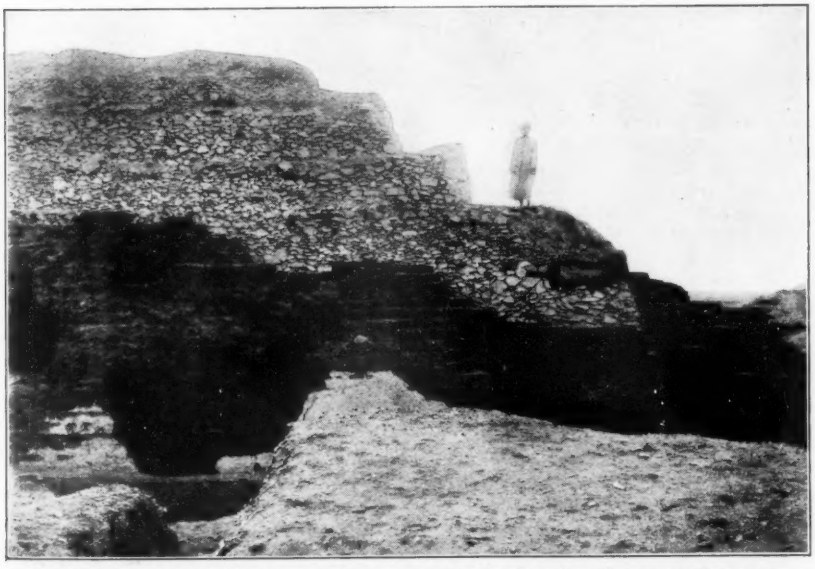
WITHIN the pyramid precinct wall are the remains of a miniature pyramid, perhaps a queen's, on the south, and of a large, presumably a royal, mastabah-tomb on the north.

It is not known where Seneferu was buried. If it was at Meydum, his body was subsequently removed, either by tomb robbers, in which case it was probably destroyed, or by his pious successors who wished to avoid just such a catastrophe, in which case there is a fair chance of yet discovering it, either at Meydum, or at one of the other great Fourth Dynasty cemeteries of lower Egypt. The transferred burial of one of his Queens, Hetep-heres, mother of Cheops, was found recently by the Harvard-Boston Expedition near her son's pyramid at Gizeh, near which is also the tomb of Seneferu's eldest daughter, Nefert-kau, sister-wife of Cheops. His eldest son, Ka-Nefer, on the other hand, was buried at Dahshur, (where Seneferu had built a second pyramid, not as a tomb, but as a cenotaph) and two other sons and their wives were buried at Meydum. From the tomb of one of these royal couples, Ra-hotep and Nefert, came their portrait statues (now in the Cairo Museum) which many people consider the finest known Egyptian statues, and from the other, that of Nefer-Maat and Stet, the equally famous painting of Geese (also in Cairo) and a beautifully painted fragment in the Museum of the University of Pennsylvania.

All around the pyramid of Seneferu stretches a vast cemetery, including examples of various types of burials used in Egypt from the Fourth Dynasty down through Ptolemaic times (3000-300 B.C.), a strong indication of the enduring renown of the sacred character of the site.

In rock-cut chambers piled-up coffins gave the appearance of a forgotten lumber room

Simultaneously with the work on the pyramid Mr. Rowe started clearing a large mastabah (Number 17), which is some 350 feet long and half as broad, and is situated just to the northeast of the pyramid. The name of the original owner has not yet been discovered, but it must have belonged to a member of the royal family or at least to a very important person. Its construction proved to be analagous to that of the pyramid; that is, it was built originally in three steps, which were later filled in to give the even inward slope of a mastabah. Two brick-faced ramps led from the valley up to the eastern face of the tomb. The northern one once led to the top of the mastabah, and the southern one to a little chapel, or niche, of which only the floor now remains, but traces of the walls, as thick as the chapel was wide, enabled Mr. Rowe to reconstruct the plan of an imposing building of pure white limestone. The walls were once highly polished, and the hard stones used in the process were found in the debris nearby.



North end of east side of mastabah tomb No. 17 showing the stepped stages in the stone core which were later filled in to support a brick casing

PROFESSOR PETRIE found a tomb chamber behind the niche when he worked at Meydum, so the discovery this year of a second niche at the northern end of the same side, led Mr. Rowe to hunt for another chamber and possible burial in it, at that end of the tomb. When sending his last report, he had not yet found it, but the search goes on.

In clearing the heavy retaining walls of the mastabah, he found that they were honeycombed with intrusive (i. e.—later) burials, most of them dating from the New Empire (1500 B.C.) and later. They represent chiefly the burials of the common people, and fall into three main catagories:

(1) Unwrapped skeletons, and mummies buried simply in linen wrappings,

often fringed, occasionally with green borders;

(2) Mummies to which an additional covering of reed or palm-frond mats were added; and

(3) Mummies in coffins. Rectangular coffins were usually undecorated except for a coat of whitewash, and confined to the burials of children, adults being buried in rather crude anthropoid coffins of the type of "mummy cases" to be seen in most museum collections of Egyptian antiquities.

In the mastabah, or noble's tomb No. 17, the north (outer) casing wall is 56 feet high. Note the excellent brickwork

Pottery dishes and bowls buried with the mummies contained grapes, dates, palm-fruit, pomegranates, or other food, and of course there was an abundance of the essential equipment for a pleasant after-life which is usually found in Egyptian tombs: boxes of eye-paint, trinket-boxes of wood, amulets, scarabs, beads, earrings, pins and bracelets, combs of wood and haircurlers of bronze, the scribe's palettes and the craftsman's tools.

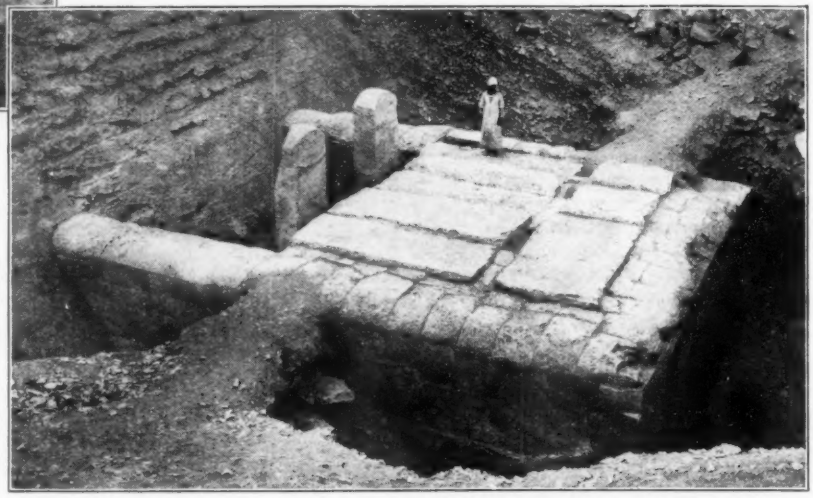
THE burial of so many persons in the actual walls of the mastabah, (not a very convenient place), indicates that the tomb was highly venerated 2000 years and more after it was built, and Mr. Rowe suggests that as the only person we know of who was so long venerated was a magician, Zedi by name, who lived in the time of Cheops, and who at the age of 110 ate 500 loaves of bread and a haunch of beef, and drank a hundred jugs of beer a day, the great mastabah might have belonged, either actually or traditionally, to this picturesque and very remarkable person.

Just to the east of the great mastabah Mr. Rowe found a miniature replica of it; it had been plundered in antiquity, and only one of the three pits beneath it contained the original Fourth Dynasty burials. Of the many types of burials already cleared in the neighborhood of the pyramid, the majority belong to the New Empire, a thousand years later than the pyramid and mastabah-tombs. There are however, a number of contemporary, that is Fourth Dynasty, tombs, most of them simply large pits with two or three recesses in the sides, in which lay skeletons, although two of the number so far excavated had large masonry chambers, illustrative of the increasing use of stone in place of brick for private as well as royal tombs in this period.

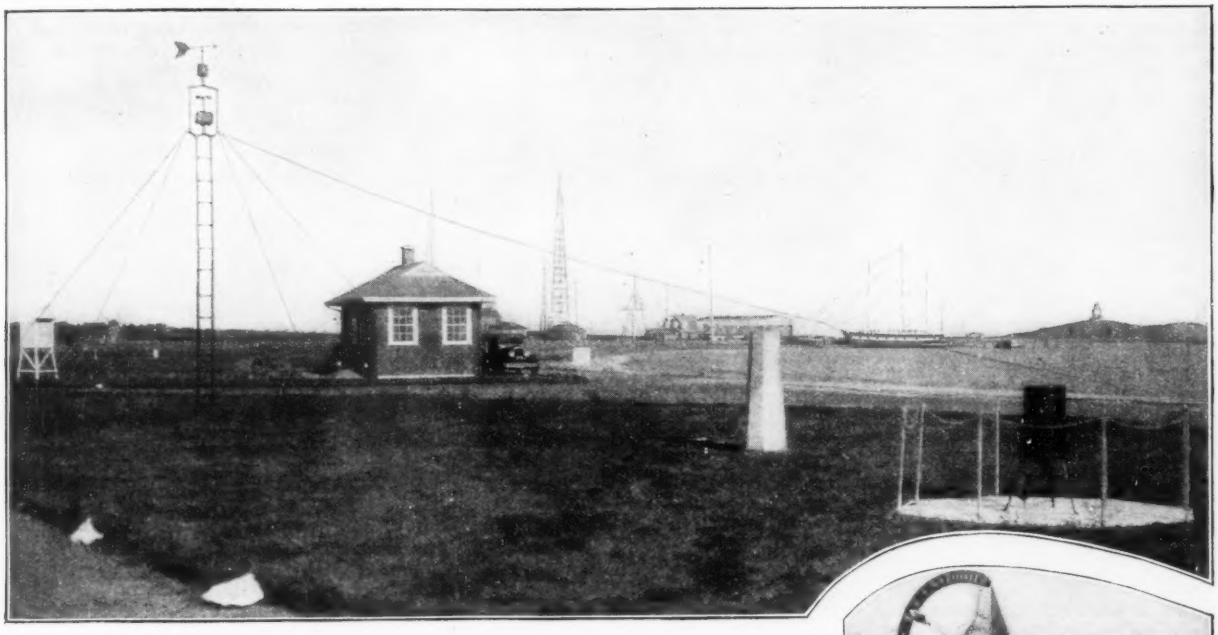
The most exciting and spectacular discovery of the season came in January, when, exploring a depression in the sand to the southwest of the pyramid, Mr. Rowe came upon a group of twelve rock-cut chambers, many of them stacked ceiling-high with coffins, "for all the world," he wrote, "like a forgotten lumber room." There were 101 mummies, besides 29 simple burials, the largest number of Ptolemaic mummies ever found together in Egypt. Of course the tomb had to be guarded day and night until it was cleared, and the first night the Arab workmen were afraid to sleep there until two of the staff joined them, and at that passed most of the night exchanging ghost stories. "They certainly had the right setting in which to relate their experiences," Mr. Rowe added, in his report on the latest discoveries.

The majority of the coffins belong to the Twentieth Dynasty (c. 1200 B.C.) or later, and one of these contained the finest mummy yet discovered at Meydum. Its outer coffin was badly damaged by rock falls within the room, but the inner one, beautifully decorated, was well preserved, as was also the mummy itself, covered with a network of glazed pottery beads; on its head was a gilded mask, and on its breast a golden winged scarab. Two of the coffins are Twelfth Dynasty (c. 2000 B.C.), delicately painted with texts from the Heliopolitan Recension of the Book of the Dead, prayers for offerings of cakes, ale, beef, geese, bread-rolls, clothes, incense, and oil on festival days. "O lady of the house, Sat-Her-em-hat, triumphant, revered before the gods who are in the other world, they transfigure thee. Take to thee thy head, and collect to thee thy bones," says one verse.

AND truly, the bones of those long-buried Egyptians who strove so hard to preserve them against time, and so cunningly to hide them in pits, pyramids, and shafts, from the impious tomb robbers of their own day, are safer now than ever, in the reverent hands of science. The careful excavator is bound to earnest respect for the remains of these long-forgotten people, lest he lose through heedlessness some minute bit of evidence of great scientific value, and he spares no pains to develop the all-seeing eye and the sympathetic mind that may enable him to reconstruct for us, vividly, accurately, and at last completely, the life and thought of this great civilization that vanished from the earth so many centuries ago.



Against the face of the pyramid is a temple consisting of a vestibule and a room; behind stand two *stelae* or pillars, with an offering table between. The location of this temple is shown in the model illustrated on page 11



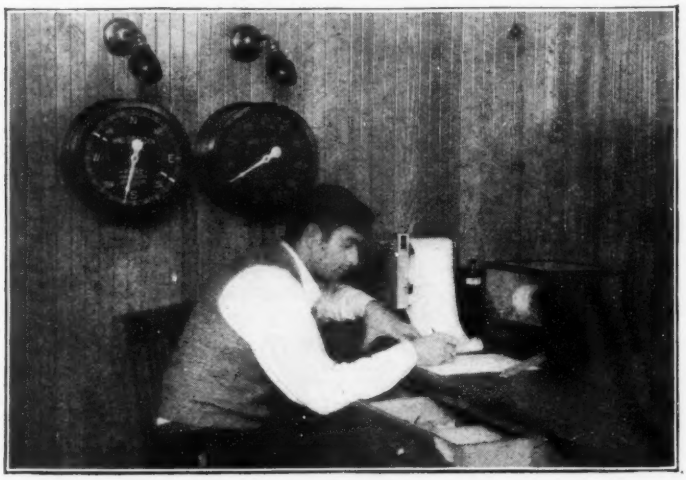
Researches In Fog

FOG, still the enemy of the navigator on the sea and in the air, is being put "under the microscope" at Massachusetts Institute of Technology's new meteorological laboratory at Round Hill, Massachusetts. The observatory's aim is to gain new knowledge of the atmospheric conditions that produce the score or more forms of fog that scientists have classified, and to develop methods of forecasting and possible future prevention and dissipation of fog.

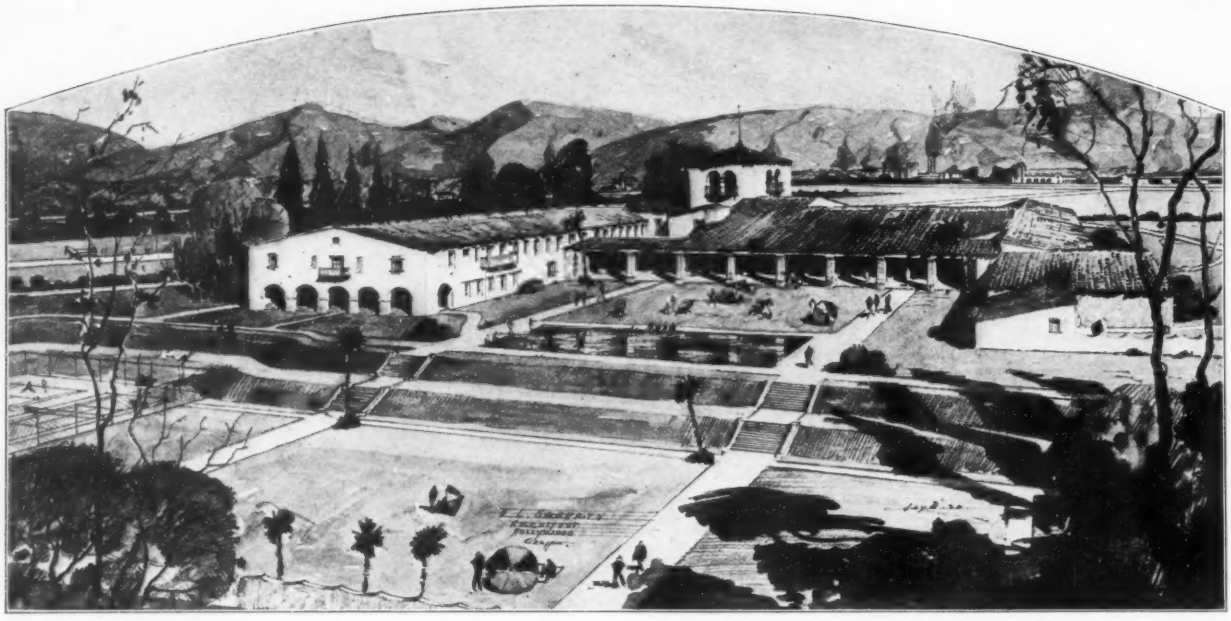
The observatory will seek to develop, first of all, an accurate method of measuring absolute humidity. Distribution of temperature in fogs and clouds of various heights will be studied, and determinations of the thickness of fog banks will be made. Throughout the studies, the various physical characteristics of fogs will be correlated with weather conditions.

Among the studies now being made is one that concerns the navigation and landing of aircraft in fog, as well as methods of communication between pilots and the ground, and between aircraft in flight.

These studies include: the use of special navigation instruments, research in the penetration of lights of various colors through fog, methods of accurately determining altitude above the nearest ground instead of sea level, and visible and invisible electrical airport landing beacons.



At the top of the page is a general view of the new meteorological observatory on the estate of Colonel E. H. R. Green. In the second illustration down, a pointer is sighted at a point on a nearby cloud to determine cloud ceiling. *Directly above:* the electrically operated rain gage which registers precipitation in hundredths of inches. *At left:* recording room containing wind direction and velocity meters and a barograph



An architect's drawing of the clubhouse and grounds at Grand Central Air Terminal, Los Angeles, which the Flying Club of California has leased from the owners of the airport. Further details are given in the text

Flying Clubs for Private Fliers

By Charles L. Lawrance*

THERE are three hundred and four flying clubs in the United States today owning plane equipment. This figure is derived from reports of the Department of Commerce covering the licensing of aircraft and includes all cases where a group of individuals have jointly bought a licensed airplane. Undoubtedly many of the clubs included in the figure are of extremely loose organization owning but a single plane and renting hangar space from the nearest airport. Yet the number itself is surprising. It is estimated that 50 percent of the clubs have sprung up during the past 18 months.

In other words, American men and women are taking to the air through the most practical means at hand—the flying club. By organizing into groups, people can afford to buy and to maintain an airplane the cost of which may be beyond the means of any one of the group. The small flying club is one of the most important manifestations of democracy in the airplane field today. It means that flying is not only for the rich but is possible for men of moderate means who are willing to work together so that they may fly.

In no place is this co-operative movement toward flying more clearly marked than in American colleges. While only at Harvard University do students own their own ship, yet the tendency to combine into organized units to promote flying has touched nearly all of the great universities. On May 10 in connection with the Air Show in New York City the first college aeronautical conference was held. Delegates from the flying clubs of 10 colleges were flown to New York in planes of the Curtiss-Wright Flying Service which picked up representatives from as far west as the University of Kansas.

OTHER universities represented included the University of Illinois, the University of Michigan, Ohio State University, and New York University. In every case it was reported that members of the clubs were putting in flying time with planes rented from the nearest airport. In some cases faculty opposition was reported, but as a rule professors themselves were said to be interested in the movement. The membership of every club included a number of licensed pilots, in some cases of the higher grades.

Thus the flying club, even where no equipment is owned, is a powerful factor in increasing the number of people who fly and know how to fly. At the same time larger clubs have made flying a far more comfortable and convenient thing than it ever has been before. This is especially true in the case of such a club as the Aviation Country Club of Long Island opened over a year ago. This club, modeled more on the flying clubs of England and Canada, owns its own clubhouse and field as well as four planes. It includes an associate membership of 180. Fifty planes are owned privately.

The formation of such a club represents a large outlay of capital and its membership is of necessity limited to the more wealthy type of individual. On the other hand the small, loosely organized club which rents hangar space from the nearest airport is under the handicap of having no clubhouse or headquarters. A compromise between these two types of club is now being worked out by the Flying Club of California which in July will move into the clubhouse being built for it at Grand Central Air Terminal outside of Los Angeles.

The expense of building the 200,000-dollar Spanish-style clubhouse is being borne entirely by the Curtiss-Wright Airports Corporation, the owners of Grand Central Air Terminal. The corporation is renting the clubhouse to the Flying Club of California for a period of 20 years. Because the rental is relatively low, the dues of the Flying Club of California are only six dollars

*See "Among Our Contributors," page 5.

a month. Its members, however, will enjoy one of the most luxurious clubhouses in the country, equipped with dining and sitting room, squash courts, and swimming pool, with tennis courts outside and two golf courses immediately adjoining.

It is evident that membership in such a club is at once attractive to a man who, on the one hand, could not afford to join a club which owns its own house and field, and who, on the other hand, is unwilling to put up with the inconveniences inherent in a club which has no permanent headquarters. It is altogether probable that the next few years will see clubs similar to the Flying Club of California established at the great eastern and middle-western airports.

In the vicinity of New York, for example, there are a number of fields at which flying clubs could establish themselves in co-operation with the owners. Land has been set aside at the Curtiss-Wright Airport at Valley Stream for the building of a clubhouse for lease to a private flying club. Residents of the Oranges and Morristown, New Jersey, on the other hand, may some day organize into a club which will make use of the facilities of Essex Airport at Caldwell. The fact that many New Yorkers live in the country during the summer makes such ports particularly well suited to flying clubs.

Members of a flying club which has its clubhouse at a large landing field naturally enjoy all of the facilities of the port. Hangar space, machine shops, and repair facilities are all at hand. Flying instruction, always an important consideration in forming a club, is available at most large flying fields.

It is interesting now, when the United States has plenty of flying-club news and activity of its own, to look back only a year when most of our knowledge of such clubs came from abroad. The retrospect shows that, although the flying club in America is a new thing, it has already exhibited marked differences from the clubs of Europe. In no case is the difference more striking than in the matter of subsidy from the government.

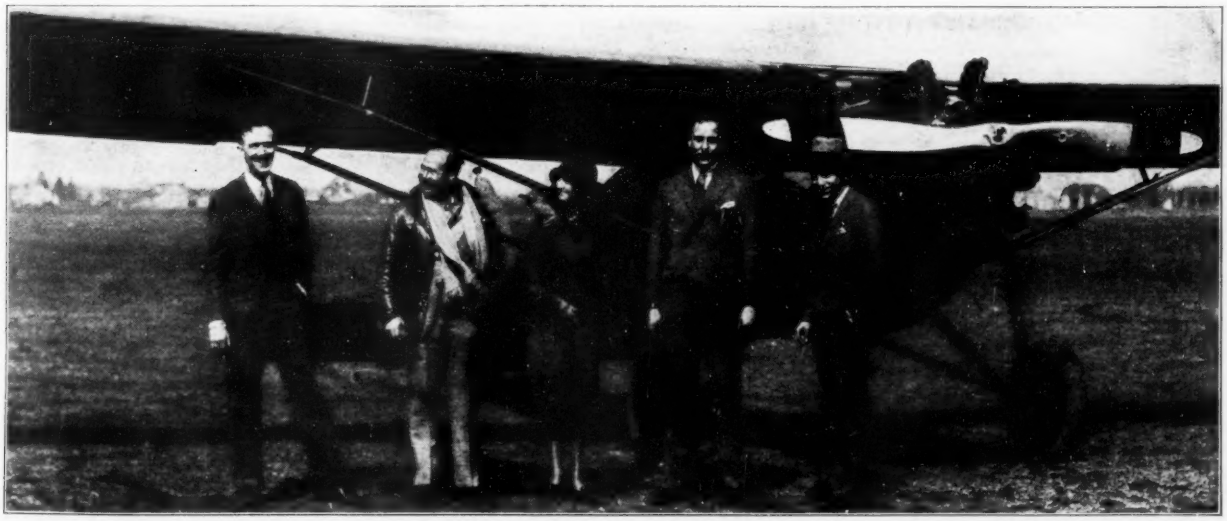
English clubs, which were the first in the field and developed soon after the war, were almost all subsidized. The English government gave 10,000 dollars to a club on its formation, for buying two airplanes and thereafter 5000 dollars a year for purposes of upkeep. Under this stimulus English clubs spread rapidly and gradually came to own their own flying fields instead of using the army fields. Today English clubs include many thousands of members with much flying time to their credit.

NO subsidy has ever been given to American clubs. Although the stimulus might have developed the movement here more swiftly, in the long run the absence of subsidizing should prove beneficial. American clubs gain an enormous amount of vitality by standing on their own feet financially. In this connection it should be noted that just as American clubs have proceeded without government aid, so, too, members of such a club as the Aviation Country Club of Long Island have tended to buy their own planes rather than to depend on the planes of the club. The fact that 50 planes are privately owned by members of this club is a distinct departure from European tradition.

A glance at the roster of the planes owned by members of the Aviation Country Club of Long Island discloses a third difference. The roster includes not only small planes such as the Moth but also cabin planes such as the Travel Air, the Robin, and the Keystone Loening amphibion. In other words, pleasure flying in America does not necessarily mean "light" flying as it does in England where distances are so much shorter. While the Englishman can use a small plane for getting to his week-end destination, New Yorkers who wish to fly to Florida or the Thousand Islands will of necessity turn to the heavier cabin type of plane.

The fact that American clubs have been developing rapidly and along their own lines should not obscure the fact that flying clubs have progressed in other countries. In Canada, for example, during 1929, members of its 23 large flying clubs flew over 1,232,000 miles in 15,400 hours of flying time. Total membership in Canadian clubs is 5092 and at the end of 1929 there were 396 solo flyers, 165 private pilots, and 58 commercial pilots—all of them trained in club flying schools. In France the flying-club movement has also developed on a large scale. There are at least nine regional clubs of the Aero-Club of France with a membership totaling close to 9000 individuals. In 1929 these members flew over 8000 hours.

The development of foreign flying clubs has in the past been a stimulus and guide to America and will no doubt remain so for some time to come. The rapid spread of small clubs throughout the country, however, in the past year indicates that America contains the possibilities of developing a system of flying clubs proportional to its size and wealth. The coming year should see more small clubs formed and the organization of many existing clubs into tighter and more efficient units. The building of private clubhouses at the great airports of the country should follow naturally and with far-reaching results. The flying club is important to American aviation: it is a powerful influence in leading people to fly and to learn to fly.



A few of the members of the Long Island Aviation Country Club, with a member-owned plane

OUR POINT OF VIEW

Naval Officers in Aviation

IN view of aviation's unquestionable importance in the defense of the country, it will doubtless come as a distinct surprise to most people to learn that there is a considerable lack of knowledge of it among the older officers of the Navy. As a result of this fact, it is said that a certain amount of prejudice exists today within the Navy itself.

The natural way to overcome this prejudice and increase the efficiency of the Navy in these days when all naval activities are so closely associated in some way or another with aviation, would seem to be to train as fliers some of the older officers who naturally exercise the higher commands. Personal knowledge of aviation coupled with their years of experience on the water would enable these seasoned men to exercise their commands more intelligently and efficiently in co-ordinating the activities of the fighting fleet with those of the air fleet.

It is claimed that the Navy Department excludes the senior officers from all opportunity to take the flight training course at the Naval Air Training Station at Pensacola—this on an arbitrary basis whether or not they are physically and temperamentally qualified. It is the announced purpose to concentrate on younger officer pilots. At the same time, however, more than half the capacity of the training school at Pensacola is taken up by enlisted men and reserves on whom the government has only one to three years' claim at the outside. The thorough training there enables these men to qualify for positions in civil life at government expense.

Senior officers who are physically qualified, should not only be allowed to take this course, but should be forced to take it. It is believed that the efficiency of the Navy will suffer if the older officers who command it know nothing of aviation, and the only way they can understand it is through learning to fly.

Engineering Opportunities

TO the youth who expects to take up engineering but cannot decide in what branch of it to major, we suggest an investigation of the possibilities in highway engineering. Perhaps the fastest growing of the newer engineering fields, highway engineering concerns all the activities that have to do with the highway industry which has attained the rank of sixth of the nation's industries, financially.

With a production of over 5,000,000 motor vehicles and a total registration of 26,400,000 in this country last year, and a steadily increasing production each year, the need for more and better roads is impressively indicated. Registration of automobiles will grow at an amazing pace and highways must be built for them. For an indefinite period of years, there will be plenty of work for road builders, road machinery manufacturers, highway planners, cement and asphalt chemists, and others. The vast scope of the industry is of such a nature as to affect the daily life of practically every citizen of almost every country of the world.

Of the total 3,016,281 miles of highway in the United States, only 660,000 miles are surfaced—or slightly more than 20 percent. Fortunately our people are highway conscious and it is certain, therefore, that this percentage will rapidly mount. This is borne out by the fact that Congress passed this year, with rare speed, a bill for adding 50,000,000 dollars to the present 75,000,000 which is given the states to build highways in the Federal Aid Program.

With so much work necessary on roads at home and an increasingly larger amount necessary abroad, it may be said without fear of contradiction that highway engineering today offers as fine a career as did electrical engineering in its early days—and with a decidedly wider field for the application of particular talents and aptitudes.

Declining Conversational English

IS our coversational English or, more specifically, American language becoming debilitated through disuse? Many of us have thought so, but indications point that way more than ever if we are to judge by the results of an investigation conducted in New York City by American Telephone and Telegraph Company engineers who listened in on toll circuits over which business calls predominated.

Of the 79,390 words recorded, 30 simple words—principally the personal pronouns, prepositions, conjunctions, and a few verbs—made up nearly half. More astonishing still is the fact that 155 words, including the 30 already mentioned, made up more than 80 percent. Purists and philologists will be horrified to learn that "shall" was heard only six times; while "yeah," "uh-huh," and "er" were plentiful; and the grunts and monosyllabic replies recorded ran into the thousands.

It has been remarked that this study shows a "facility of expression and economy of vocabulary" that is apparently held to be congruous with the rapid pace of our age. But to the thinking man, it is appalling, in that it shows an utter lack of imagination among business men, a lazy mentality that does not fit into the picture of modern efficient business. It is hoped that this sorry record, spoken into the telephone by New York business men, is not representative of the country at large. If it is, we are sure to retrogress. If we take up once again the grunting "speech" of our prehistoric forbears, the "culture" of the machine age may be set down in the histories of a future Renaissance in a hastily written paragraph or two!

Analyzing the Naval Treaty

PRESIDENT HOOVER lost no time in transmitting the naval limitation treaty to the Senate. The Committee on Foreign Affairs and the Committee on Naval Affairs are giving immediate consideration to the treaty. They will scrutinize its provisions carefully and will hold extensive public hearings on the subject matter before giving their approval. The House Committee on Naval Affairs has demanded full information of the effect the treaty will have on the relative efficiency of our Navy. This consideration by Congress is essential. We are committing ourselves to an important agreement; no urgency demands the immediate approval of the treaty. The responsibility for our national defense rests on Congress; and it is the duty of Congress to examine minutely into all the aspects and ramifications of this treaty.

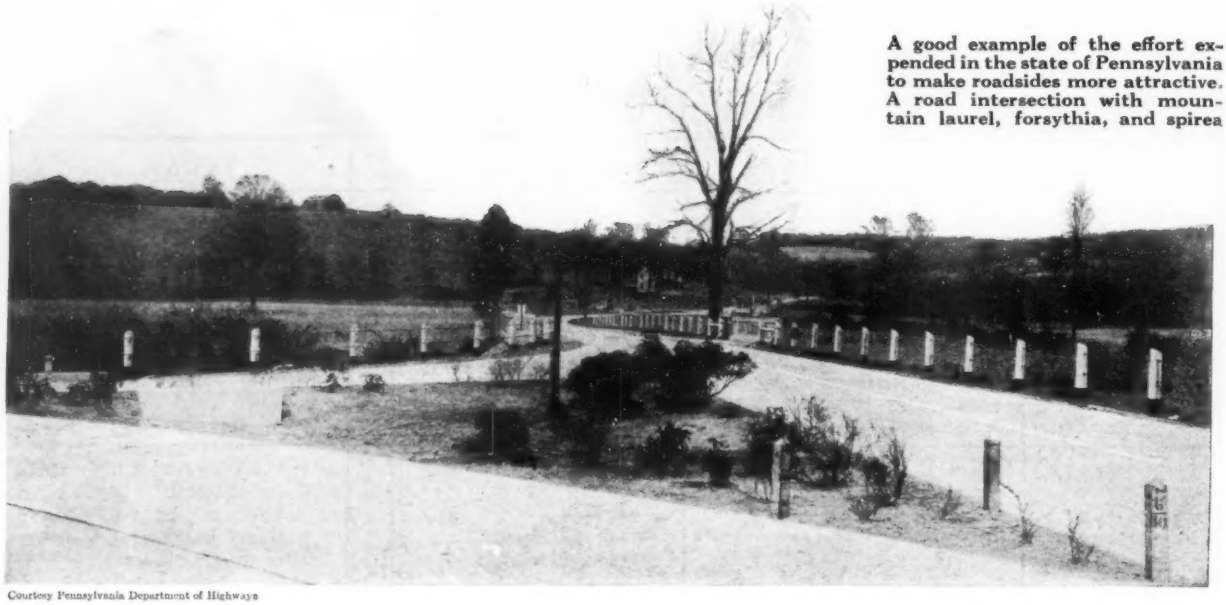
We confess that we are not enthusiastic over the part of the treaty fixing the ratios between Japan and the United States; we have the uncomfortable feeling that our delegation was embarrassed by our present naval inferiority and the Administration's eagerness for an agreement and could not properly support our country's position. In his prepared statement to the Senate Foreign Affairs Committee, Mr. Stimson tacitly admitted that, having already sacrificed our superiority in capital ships, we were handicapped throughout the negotiations. On the other hand, the position

(*Please turn to page* 70)

RESULTS of NAVAL CONFERENCE

Types	UNITED STATES	GREAT BRITAIN	JAPAN
CAPITAL SHIPS			
Remaining	15 Ships — 453,000 Tons	15 Ships — 472,000 Tons	9 Ships — 266,000 Tons
To be scrapped	3 Ships — 70,000 Tons	5 Ships — 134,000 Tons	1 Ship — 27,000 Tons
AIRCRAFT CARRIERS			
Remaining	3 Ships — 76,286 Tons	6 Ships — 115,000 Tons	3 Ships — 61,000 Tons
To be built	4 Ships — 58,714 Tons	3 Ships — 20,000 Tons	3 Ships — 20,000 Tons
CRUISERS 8"			
Remaining	2 Ships — 20,000 Tons	11 Ships — 110,000 Tons	8 Ships — 68,000 Tons
To be built	16 Ships — 160,000 Tons	4 Ships — 37,000 Tons	4 Ships — 40,000 Tons
CRUISERS 6"			
Remaining	10 Ships — 70,500 Tons	35 Ships — 192,000 Tons	20 Ships — 94,000 Tons
To be built	10 Ships — 73,000 Tons	NONE	1 Ship — 7,000 Tons
DESTROYERS			
Remaining	143 Ships — 150,000 Tons	132 Ships — 150,000 Tons	87 Ships — 105,000 Tons
To be scrapped	80 Ships — 76,000 Tons	38 Ships — 34,000 Tons	24 Ships — 17,000 Tons
SUBMARINES			
Remaining	55 Ships — 52,500 Tons	44 Ships — 52,500 Tons	38 Ships — 52,500 Tons
To be scrapped	24 Ships — 12,000 Tons	19 Ships — 11,000 Tons	33 Ships — 26,000 Tons

RELATIVE tonnage, in the six fighting ship classes, of the three signatory powers to the London agreement. The situation on May 1, 1930, showing the amount of building and scrapping necessary to carry out the provisions of the agreement after its ratification—drawn to a relative scale. "To be built" includes all ships not 100 percent complete, as, for example, six of our 16 eight-inch-gun cruisers which are 60 percent complete. Obsolete ships, such as destroyers over 16 years old and submarines over 13 years old, are not included in "ships to be scrapped."



A good example of the effort expended in the state of Pennsylvania to make roadsides more attractive. A road intersection with mountain laurel, forsythia, and spirea

Courtesy Pennsylvania Department of Highways

Beautiful Roadsides

Move for Sightly Highways Is Becoming Countrywide

By Walter E. Burton

MILLIONS of American motorists who seek restful scenery, charm, and recreation on the open road are beginning to ask for better-looking highways. To a limited extent, their demand is being answered. But there is a surprising hesitancy of some states in making use of available public funds for highway beautification.

An act of May 21, 1928, gave authorization for the inclusion of tree planting as a part of federal-aid road construction. But, more than a year after the act became effective, the Bureau of Public Roads had received no request for aid in a single road-beautification program. This does not indicate that nothing has been done to increase the beauty of modern roads, for, on the contrary, considerable progress has been made in many states.

Signboards usually constitute the first objective of a road-beautification movement. All but 11 states exert some kind of regulatory influence over roadside signs, yet not one prohibits their erection. The situation is a ticklish one because it concerns personal property rights. Some of the larger advertisers have voluntarily abandoned roadside advertising, choosing to carry their message to the public through other channels.

"In practically all cases these roadside advertisements merely repeat, in the same form, appeals that are made quite properly and insistently through other agencies," Thomas H. MacDonald, Chief of the Bureau of Public Roads, stated in his last annual report. "They are not needed by the public, and are of doubtful value to advertisers. It is hoped that means may be found by suitable legislation to effect their complete elimination upon all roads constructed in part with money appropriated by the national government."

NEVADA is the only state having laws seeking to regulate the erection of signboards. No permit is issued for signs that will measurably mar the roadside beauty, or obstruct views. Connecticut regulates signs erected by filling stations and similar business places. Illinois controls erection of signs within right-of-way limits of trunk-line highways, but has difficulty with signs inside corporation limits. California issues permits only for signs located on the right-of-way adjacent to the business they advertise. Massachusetts keeps advertising matter 300 feet from the highway, except where it is contiguous to the business it concerns.

In recent years, with the rapid development of improved roads, there has been little attention given to their esthetic aspects. Lately, a few states, notably Massachusetts, California, Connecticut, Pennsylvania, and Florida, have begun to take the matter seriously. One surprising thing was learned: Road beauty is not a costly improvement.

By judicious planting of native trees, perennial flowers, and shrubs along rights-of-way; by removing objects that are in themselves ugly; by restricting sign-board placing; and by a few other simple processes, a plain or a downright ugly road can be converted into a thing of lasting beauty.

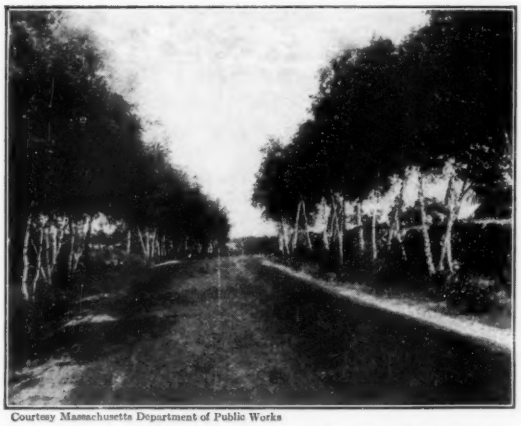
Massachusetts, which started improving the beauty of its roads in 1921, frequently is pointed out as a model for other states. The State Department of Public Works has charge of the work. When a new road is built, it is made wide enough to permit landscaping. The maintenance division does the actual work. At Palmer is a state nursery for the propagation of trees and shrubs. This also is a training station for men who care for the plantings.

The first step in the work is the preservation of trees and plants already established. Maintenance men remove dead trees and cut stumps six inches below the ground, trim away dead or broken limbs, treat wounds by trimming and filling with tar, repair cavities by approved methods of tree surgery, and re-inforce split

and weakened parts with cables. Undesirable branches, such as those which rub together, are removed. When advisable, trees are sprayed.

Vistas are developed by trimming away underbrush and removing obstructing trees. Roadside springs are cleaned and made usable. Seats are provided at convenient points, and rubbish barrels are placed at strategic positions.

In new planting, only domestic trees and shrubs are used. Gravel and sand slopes are a constant source of trouble because of water erosion. They are treated by planting small pines, sweet ferns, and other suitable vegetation. Whenever there is enough soil of the proper kind, grass or shrubs are planted. Extensive tree and shrub planting is confined to new roads 60 or more feet wide, so that there will be little or no subsequent widening operations to destroy the beauty. Shade trees are planted in groups, not in monotonous, military lines.



Courtesy Massachusetts Department of Public Works

A group of birches bordering a New England road. Thinned out and trimmed, they increase the scenic value and do not obstruct the view

THE procedure followed in landscaping is systematic. After construction is complete, a man trained in landscape planning locates with colored pencils on a blueprint the positions of shrubs and trees. Stakes are then placed on the area being treated, to indicate the plan of digging. Dynamite is used for forming holes because it loosens the ground over a considerable area, and is about half as costly as manual or machine digging. High-grade soil is used to fill the pits. An order for planting material is sent to the nursery, and the supplies are delivered by trucks. After new shrubs are planted and well established, a final grubbing is carried out.

California considers both beauty and practical aspects of roadside improvement. Trees are planted; native wild ferns, shrubs, moss, trees, and flowers are preserved; and weed areas attacked. For utilitarian reasons, dry grass is burned, and obnoxious weeds such as the puncture vine, yellow star thistle, and mustard weed, are removed. The initial cost of tree planting is largely borne by civic and other groups, but maintenance is carried on by the state. Periodic watering of trees frequently is necessary.

Pennsylvania is one of the most recent converts to the idea of highway beauty. In 1928 a forestry unit, consisting of five trained foresters and three landscape architects, was created to act under the highway forester. Field men are located in eight state districts, and their duties are to plant and care for shade trees, plant slopes and evergreen snowbreaks, and create open views.

Outside organizations have helped considerably since the work started, by providing trees and shrubs.

In general, the ideas used in the majority of states which give attention to highway beauty are similar. In Florida, however, the conception of beauty is somewhat different. This is largely because of the peculiar quality of Florida's semi-tropical scenery. Officials believe that the most beautiful landscape in the state consists of a well-paved road, with ditches and slopes planted in grass and carefully groomed, and with the characteristic Florida scenery forming a background on each side. Rubbish is kept cleared away, and planting of large trees and shrubs along the right-of-way is not encouraged.

It is pretty well agreed that there are few ways in which a greater return, dollar for dollar, can be obtained with public funds than by spending a little more for beautifying highways. Aside from the purely esthetic aspects of the work, roadside property values invariably are raised. A beautiful road creates a better sense of self respect in the community, and it favorably impresses the visitor who, besides bringing a measure of profit to local business when he is persuaded to linger, carries away for distribution to other places impressions which he gained in passing through.

Courtesy State Road Department of Florida

Artificial aids to safe motoring such as these neatly constructed guard rails can also be made very attractive

Courtesy Massachusetts Department of Public Works

To some, a paved road is but an artificial scar across the country, but if it is well kept, it may become a thing of beauty. The shoulders in this case are sodded and clean

Courtesy Pennsylvania Department of Highways

Oriental plane trees seven years after planting. The planting of these was carefully done so that they took root firmly and but little further care was necessary

Planet X

By Henry Norris Russell, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE widespread and justified sensation caused by the discovery of the new major planet of our solar system will have passed long before these words will have reached America—much less see the light in print. But the discovery itself is so important and illustrates so well the methods of modern astronomy that it should not fail to be set out in order here.

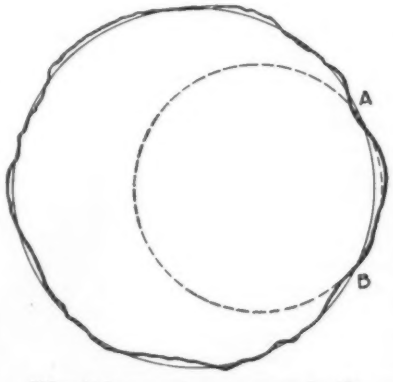
Everyone knows how the last great planet to be discovered was found. After Uranus had been known for half a century or more it was found to deviate from the orbit determined from the first 50 years of observations, after full allowance had been made for the attraction of the then known planets. Some unknown body must be pulling at it and this could only be a planet still farther from the sun. To calculate from the observed perturbations of Uranus' motion the orbit of the unknown planet which produced them was a very intricate matter. But the problem was solved by LeVerrier in France, and Adams in England, and the planet Neptune was found within a degree or so of the place in the heavens which these calculations pointed out.

Through all the 84 years since the discovery of Neptune until the present, the possibility that there was a still remoter planet has been realized, and now that it has been discovered the layman naturally may ask, "Why, if it was there all the time, did not the mathematicians tell us where to find it?" As a matter of fact they did, but through no fault of theirs their answer could not be as precise as it was for the earlier problem of Neptune.

To calculate the perturbations produced in the motion of one planet by the attraction of another is no small task, even when the orbits of both are accurately known in advance; and to work backward from the perturbations of a known planet to the orbit of an unknown one is much harder. But mathematical astronomers are used to hard problems and know how to solve this one. The worst difficulty is that to find the perturbations we must compare the observed positions of the known planet with those which it *would have had* if the unknown planet had not been attracted. To determine the latter is evidently difficult.

To see how it can be done let us ignore the attractions of the known planets (or suppose that, as in practice, their effects have been calculated and allowed for). We then know that, barring unknown influences, the planet should move in an exact ellipse about the sun in accordance with Kepler's familiar laws. What the size and shape of this ellipse may be can be found only by observing the planet. If no extraneous forces are acting, the planet will follow the same ellipse time after time, but if an unknown planet is perturbing it the tracks in the second and subsequent revolution will not be quite the same and the differences will reveal the amount and nature of the perturbations.

It is not actually necessary to wait quite so long. When a planet has been well observed half around its orbit its motion along the other half can be predicted closely enough to reveal any considerable disturbances after it has been followed in this half as well. But something like a full revolution around the sun is really necessary. With observations covering only half the orbit or less, it is possible to find a "fictitious orbit" such that a planet moving in it without perturbations (save by the attractions of known bodies) will, *over the given interval of time*, always be very near the real planet—subject though it is to additional perturbations, and though in earlier or later years this will not be true.



Why it is easy to go wrong in the prediction of planets—see the text

It may help to understand this to imagine a circular hoop which has been bent and battered a little out of shape (see drawing). If we can see the whole hoop or half a photograph of it it is easy enough to strike a true circle which follows its general course, and then find the amount of the deformations from point to point. But if our photograph covers but a small part of the hoop and we try to fit a circle to it as best we can, we may draw it too large or too small, according as this particular part of the hoop has been flattened or bent too sharply.

The heavy line in the drawing represents a battered hoop which in a rough way illustrates a perturbed orbit. The circle represents the hoop before it was deformed, or the unperturbed orbit. But if we knew only the part AB of the hoop we would suppose that the whole was like the dotted circle and would greatly underestimate the amount, and sometimes even the direction, in which this portion had been bent out of shape. In quite the same way we can not get any accurate idea of the perturbations of a planet unless we have observations extending pretty well around the orbit.

Now since its discovery in 1846 Neptune has been only half way around its orbit and it is therefore practically valueless for locating an outer planet by means of its perturbations. Uranus has completed two revolutions since its discovery and is fully available, but it is nearer the sun and farther from the trans-Neptunian planet and the perturbations to be anticipated are therefore small.

Several investigators have examined the question, the most comprehensive work being probably that of the late Dr. Percival Lowell which was published in 1914 but commenced more than a decade earlier. A careful mathematical investigation indicated the existence of small perturbations just within the limit of detection, and indicated that the unknown planet which produced them must be either in the direction of the constellation Gemini or just on the opposite side of the sun. The perturbations produced by planets in these two positions were so much alike that no decisive choice between the two could be made.

Lowell estimated the new planet's distance from the sun as 43 to 44.7 astronomical units (see illustration, page 22, section 9, a' and a'.—*Ed.*)—half as much again as Neptune's—and its mass as 1/50,000th that of the sun, six times the earth's, but only one third of that of Uranus or Neptune.

Accepting these conclusions the next question was, how to find the planet. Being less massive than Neptune it was doubtless smaller, and being far from the sun it must be faintly illuminated

and far from conspicuous. Lowell estimated its probable brightness as from the 12th to the 13th magnitude (see illustration, page 22, section 10—*Ed.*). It is hopeless to search for such an object visually among the multitudes of stars and the only chance of success is by photography, employing substantially the same methods as have been proved so successful in finding asteroids; that is, the careful comparison of suitably duplicated plates of the same star fields.

A great deal of time and labor was thus spent by Dr. Lowell and his successors at the observatory which he founded at Flagstaff, Arizona, and which bears his name. In time it became clear that the distant planet was probably fainter than the original estimate, which in the nature of the case could only be very rough, and that a very powerful instrument would be required to find it. A gift from the President of Harvard, Percival Lowell's younger brother, provided an admirable instrument. It possesses a triple objective of 13 inches aperture which gives sharp star images over a wide field, and is withal very rapid.

THE new Lawrence Lowell telescope within a year of its installation has brought the long-sought planet to light. Photographs of moderate exposure covering the whole region of the heavens around the predicted position were obtained and on one of them, taken on January 21, 1930, Mr. Tombaugh of the observatory staff found "a very promising object." It was identified from its motion past the numerous fixed stars as revealed on plates of the same star field while being compared under the blink comparator. This showed that one faint star among many thousands had shifted its place by a certain expected order of distance, in the interval between the taking of the two plates. Since that date it has been carefully followed both photographically by Dr. Lampland with the 40-inch reflector and visually by E. C. Slipher and other members of the staff. Its motion in the heavens has been just what might be expected of a trans-Neptunian planet at about the distance anticipated by Lowell, and its longitude agrees closely with his predictions. There is no doubt that it is actually a new major planet much farther away than any which has previously been known.

This admirable discovery comes to the astronomers at Flagstaff as a reward of years of skillful development of methods and patient work. It is most gratifying that this long and devoted search has been crowned with full success, though we must all regret that the originator and inspirer of the campaign did not live to witness its triumphant close.

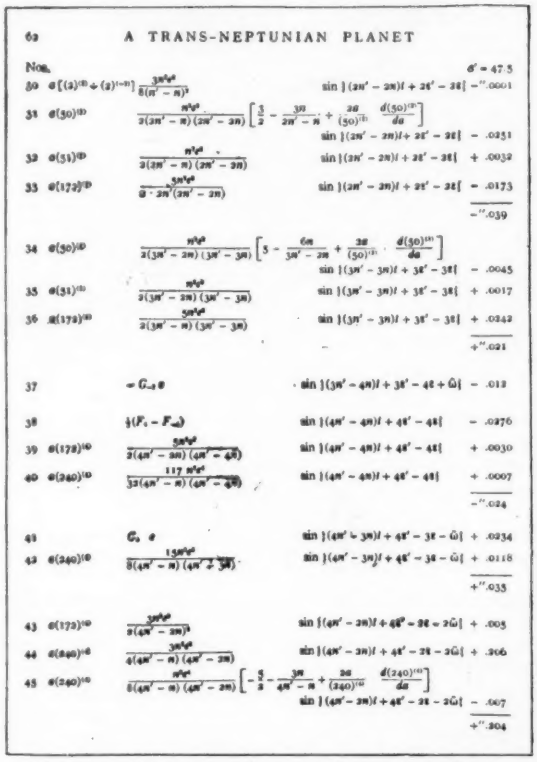
What of the new planet itself? Full knowledge comparable to that which we have regarding the other planets of our system can come only after years of further work. For example, it will be a long time before its orbit is accurately known. A fairly good orbit of a rapidly moving asteroid can be derived from three good observations separated by intervals of a week or so. For this slowly moving body intervals of a couple of months will be desirable. Before it was lost in the light of the sun, which happened in May, sufficient data to give a good preliminary orbit which will tell us where to look for the planet at the end of summer when it can again be observed, was worked out and published (April 12). Next year's observations will permit a considerably better determination; and so on.

Even after a decade, however, we will have observations covering only a very small fraction of the orbit and will still be somewhat in the position of having to determine the course of a whole circle from a small arc. It may happen that, calculating backward, the images of the planet can be found on photographs taken years before it was discovered, though it is so faint that the chance is not very good. And in this case the arc available for determining the orbit, and the calculated results, may be increased. At this early date we can be certain only that the planet is near the ecliptic, that it is moving around the sun in the same direction as the other planets, and that the inclination of its orbit plane, while greater than the other planets, as Lowell predicted (section 11.—*Ed.*) is not extremely great. The general agreement of its apparent motion with that calculated with Lowell's estimated distance of 43 to 44.7 astronomical units shows, however, that this prediction is near the truth.

Adopting provisionally this distance, which is 50 percent greater than Neptune's, what else can now be said about the planet? Its diameter must be rather small. With the 24-inch refractor at Flagstaff the planet appears as a faint stellar point and shows no sensible disk.

IF it were really as much as 10,000 miles in diameter it would show an apparent disk of 0″.5, which the experienced observers who have examined it hardly could have missed under favorable conditions. We may conclude with some confidence therefore that the new planet is little if at all larger than our earth—provided, to be sure, that the estimate of its distance here adopted is correct.

Further evidence that the planet is a small one is found in its faintness. The assigned magnitude, about 15.5, is photographic. If it is of the average color of the inner planets it should be about a magnitude brighter visually than photographically, and we may base our estimates on a visual magnitude of 14 or 14.7. This makes the planet only about 1/250th as bright, apparently, as Neptune. If Neptune could be removed to this greater distance it would look only 1/5 as bright as it does now, but even so it would outshine Planet X fifty-fold. This suggests that the diameter of the new planet is about 1/7 that of Neptune, or a little less than 3000 miles. This estimate, however, may be too small, for Neptune has the highest superficial reflecting power, or albedo, of any of the planets and a planet of lower albedo would have to be larger to reflect the same amount of light. To go to the opposite extreme we may take for comparison the moon which has about the lowest known albedo. A simple calculation shows that if removed to a distance of 45 astronomical units from us and from the sun, she would appear as a star of visual magnitude 17. Planet


62 A TRANS-NEPTUNIAN PLANET

Nos. $\sigma' = 47.5$

50 $\sigma[(2)^{(2)} + (2)^{(-2)}]\ \frac{3n^2a^2}{8(n'-n)^2}$ $\sin\{(2n'-2n)t + 2\epsilon' - 2\epsilon\}$ $-''.0001$

51 $\sigma(50)^{(2)}$ $\frac{n^2a^2}{2(2n'-n)(2n'-2n)}\left[\frac{3}{2} - \frac{3n}{2n'-n} + \frac{2a}{(50)^{(2)}}\frac{d(50)^{(2)}}{da}\right]$ $\sin\{(2n'-2n)t + 2\epsilon' - 2\epsilon\}$ $-.0251$

52 $\sigma(51)^{(2)}$ $\frac{n^2a^2}{2(2n'-n)(2n'-2n)}$ $\sin\{(2n'-2n)t + 2\epsilon' - 2\epsilon\}$ $+.0032$

53 $\sigma(172)^{(2)}$ $\frac{3n^2a^2}{8\cdot 2n'(2n'-2n)}$ $\sin\{(2n'-2n)t + 2\epsilon' - 2\epsilon\}$ $-.0173$

$-''.039$

54 $\sigma(50)^{(3)}$ $\frac{n^2a^2}{2(3n'-2n)(3n'-3n)}\left[5 - \frac{6n}{3n'-2n} + \frac{3a}{(50)^{(3)}}\frac{d(50)^{(3)}}{da}\right]$ $\sin\{(3n'-3n)t + 3\epsilon' - 3\epsilon\}$ $-.0045$

55 $\sigma(51)^{(3)}$ $\frac{n^2a^2}{2(3n'-2n)(3n'-3n)}$ $\sin\{(3n'-3n)t + 3\epsilon' - 3\epsilon\}$ $+.0017$

56 $\sigma(172)^{(3)}$ $\frac{3n^2a^2}{2(3n'-n)(3n'-3n)}$ $\sin\{(3n'-3n)t + 3\epsilon' - 3\epsilon\}$ $+.0242$

$+''.021$

57 $= G_{-4}\,\sigma$ $\sin\{(3n'-4n)t + 3\epsilon' - 4\epsilon + \Omega\}$ $-.013$

58 $\frac{1}{2}(F_1 - F_{-3})$ $\sin\{(4n'-4n)t + 4\epsilon' - 4\epsilon\}$ $-.0276$

59 $\sigma(172)^{(4)}$ $\frac{5n^2a^2}{2(4n'-3n)(4n'-4n)}$ $\sin\{(4n'-4n)t + 4\epsilon' - 4\epsilon\}$ $+.0030$

60 $\sigma(240)^{(4)}$ $\frac{117}{32}\frac{n^2a^2}{(4n'-n)(4n'-4n)}$ $\sin\{(4n'-4n)t + 4\epsilon' - 4\epsilon\}$ $+.0007$

$-''.024$

61 $G_{-3}\,\sigma$ $\sin\{(4n'-3n)t + 4\epsilon' - 3\epsilon - \Omega\}$ $+.0234$

62 $\sigma(240)^{(3)}$ $\frac{15n^2a^2}{8(4n'-n)(4n'-3n)}$ $\sin\{(4n'-3n)t + 4\epsilon' - 3\epsilon - \Omega\}$ $+.0118$

$+''.035$

63 $\sigma(172)^{(2)}$ $\frac{3n^2a^2}{2(4n'-2n)^2}$ $\sin\{(4n'-2n)t + 4\epsilon' - 2\epsilon - 2\Omega\}$ $+.005$

64 $\sigma(240)^{(2)}$ $\frac{3n^2a^2}{4(4n'-n)(4n'-2n)}$ $\sin\{(4n'-2n)t + 4\epsilon' - 2\epsilon - 2\Omega\}$ $+.306$

65 $\sigma(240)^{(1)}$ $\frac{n^2a^2}{8(4n'-n)(4n'-2n)}\left[-\frac{5}{2} - \frac{3n}{4n'-n} + \frac{2a}{(240)^{(1)}}\frac{d(240)^{(1)}}{da}\right]$ $\sin\{(4n'-2n)t + 4\epsilon' - 2\epsilon - 2\Omega\}$ $-.007$

$+''.304$

Giving an idea of modern mathematical planet predicting—a typical page from Lowell's original prediction of 1914. There are many pages like this

X appears three magnitudes or 16 times brighter, which on this hypothesis regarding its surface brightness makes its diameter four times that of the moon, or 8600 miles. It is probable that the truth lies between these two estimates, but little more can be said for there are very great differences of albedo even among the atmosphereless asteroids, and we have no means of estimating more closely what value we should use for the new planet. It may be considered, nevertheless, that it is fairly comparable in size with the four inner planets of our system, and much smaller than the four outer ones which were previously known.

The planet's mass can probably be determined at least roughly from the perturbations it produces in Uranus and Neptune when once its orbit is accurately known. The latter statement may seem inconsistent with what has already been said, but the problem here is not quite the same as before. Suppose that, in the drawing, we knew the direction in which the wavy line deviated from the circle at each point and the relative though not the absolute amounts of these deviations. We would then have much less latitude in drawing our theoretical circle than before, and could be fairly sure of its position in cases which before were

Percival Lowell

hopeless, as explained on page 20.

A planet less than 10,000 miles in diameter would be very unlikely to have a mass 1/50,000 that of our sun (section 9.—*Ed.*) for this would demand a mean density about 17 times that of water. The earth's mass is only 1/330,000th of the sun's, and if Planet X is no more massive it is hard to see how its attraction could produce the effects studied by Lowell. This discrepancy would be diminished if the planet's distance from the sun should turn out to be greater, but it is premature to discuss the matter further at present, without more dependable data.

The only hope of learning anything about the rotation of the new planet is by photometric means. If, like many of the asteroids, it should show regular periodic changes in brightness, these would reveal the rotation. But for so faint an object, the observations would be difficult.

Finally, there is little hope of detecting a satellite of the planet unless, like our moon, it should be almost comparable in size with its primary. Nevertheless it is probable that photographs will be made with the great reflectors, in order to investigate.

In conclusion, two tributes must be paid where honor is due: First, to the skill, assiduity, and devotion of the workers at the Lowell Observatory who have made this important discovery; and second, to the memory of Percival Lowell, traveler, man of letters and affairs, and observer of the planets. He did many things in the course of a crowded life and did them well. The mathematical researches took him outside his other fields of work and into a region full of traps for the unwary, yet the discovery of this new planet has justified him by his works despite the doubts of many of his contemporaries. His fame bids fair to increase as the years pass on.—*Athens, Greece.*

as further study has shown this confidence to have been misplaced; so the fine definiteness of positioning of an unknown by the bold analysis of LEVERRIER or ADAMS appears in the light of subsequent research to be only possible under certain circumstances. Analytics thought to promise the precision of a rifle and finds it must rely upon the promiscuity of a shot gun after all, though the fault lies not more in the weapon than in the uncertain bases on which it rests. But to learn of the general solution and the limitations of a problem is really as instructive and important as if it permitted specifically of exact prediction

For that, too, means advance.

SUMMARY

69. This investigation establishes the following:

1. By the most rigorous method, that of least squares throughout, taking the perturbative action through the first powers of the excentricities, the outstanding squares of the residuals from 1750 to 1903 have been reduced 71% by the admission of an outside perturbing body.

2. The inclusion of further terms yielded solutions in accordance with the first.

3. Solutions taking the years 1090–1715 also into account agreed substantially with those from the years 1750–1903.

4. So did those in which the additional years to 1910 were considered.

5. The second part of the investigation, in which the solutions were made for the second powers of the excentricities as well, gave conformable results.

6. When the probable errors of observation were reckoned, the outstanding squares of the residuals of theory excluding an outside planet proved to have been reduced by its admission from 90% to 100% nearly, the solutions seeming to confirm one another as follows:

for ε' around 180°		and for ε' around 0°	
24 obs. eqs.	99%	25 obs. eqs.	99½%
25 " "	91%	27 " "	99½%.
27 " "	89½%		
37 " "	88%		

A photographic reproduction of the final two pages —the summary—of Lowell's original prediction, published 1914 as Memoir No. 1, Volume 1, of Lowell Observatory. Forgotten by the world, it never was forgotten by the persistent Lowell Observatory Staff. Copies of the original memoir are now very rare

7. Though this would indicate an abeolute solution of the problem, it must be remembered that the actual as against the probable errors of observation might decidedly alter the result; and so might the terms above the squares in e and e' necessarily left out of account.

8. The investigation disclosed two possible solutions in each case, one with ε' around 0°, one with it around 180°; and that this duality of possible place would necessarily always be the case.

9. On the whole, the best solutions for the two gave:

ε' around 0°	ε' around 180°
ε' = 22°.1	ε' = 205°.0
a' = 43.0	a' = 44.7
m' = 1.00	m' = 1.14
e' = .203	e' = .195
$\tilde{\omega}'$ = 203°.8	$\tilde{\omega}'$ = 19°.6
hel. long. July 0, 1914 84°.0	262°.8

the unit of $m' = \frac{1}{50000}$ the mass of the *Sun*.

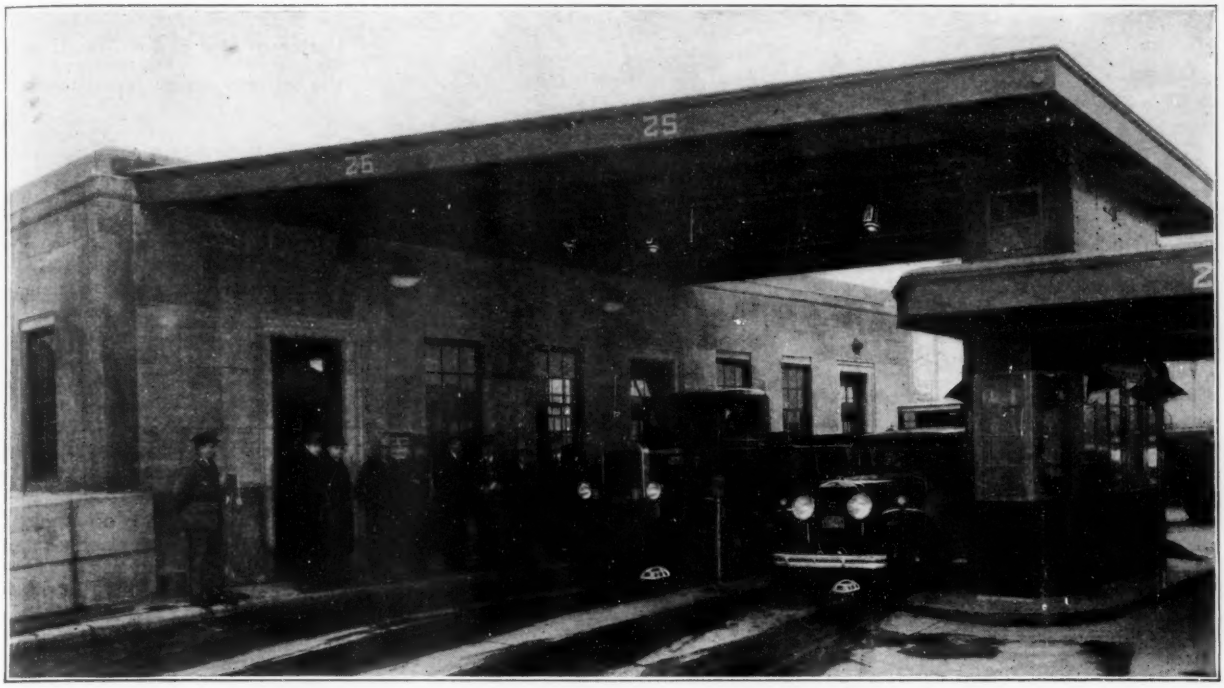
10. It indicates for the unknown a mass between *Neptune's* and the *Earth's;* a visibility of the 12-13 magnitude according to albedo; and a disk of more than 1" in diameter.

11. From the analogy of the other members of the solar family, in which excentricity and inclination are usually correlated, the inclination of its orbit to the plane of the ecliptic should be about 10°. This renders it more difficult to find.

12. Investigations on the perturbation in latitude yielded no trustworthy results. This is probably because the excentricity e' as well as the planet's other elements enter as data into the latitude observation equations.

13. The perturbative function is not discontinuous at the commensurability of period points, a fact hitherto in doubt.

14. That when an unknown is so far removed relatively from the planet it perturbs, precise prediction of its place does not seem to be possible. A general direction alone is predicable.



A toll house showing photoelectric cells in roadbed and lights overhead

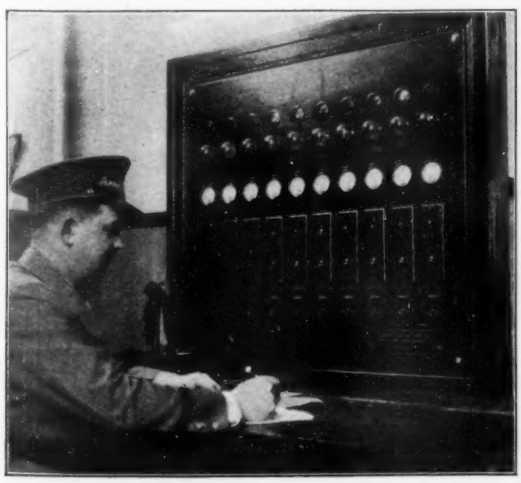
Light Counts Cars on Bridge

THE task of checking and controlling traffic over the longest span bridge in the world is being accomplished by means of photoelectric cells and light beams. The man who superintends traffic control on the new Ambassador Bridge over the Detroit River at Detroit can tell, by glancing at his control board far from the scene of operations, which traffic lanes are in operation, whether the density of traffic warrants the use of more or fewer lanes, and whether the vehicles are being cleared over the bridge efficiently. The system was devised and installed by Benjamin Cooper, a consulting engineer of New York City.

A photoelectric cell is imbedded in each of the 10 lanes provided for incoming traffic, at the point where cars must stop for payment of tolls. While the car is stopped, it intercepts a beam of light from a source in the ceiling of the toll shed. This interception causes the cell to function and it, in turn, causes a magnetic counter to register a count and also causes an indicator light to go out.

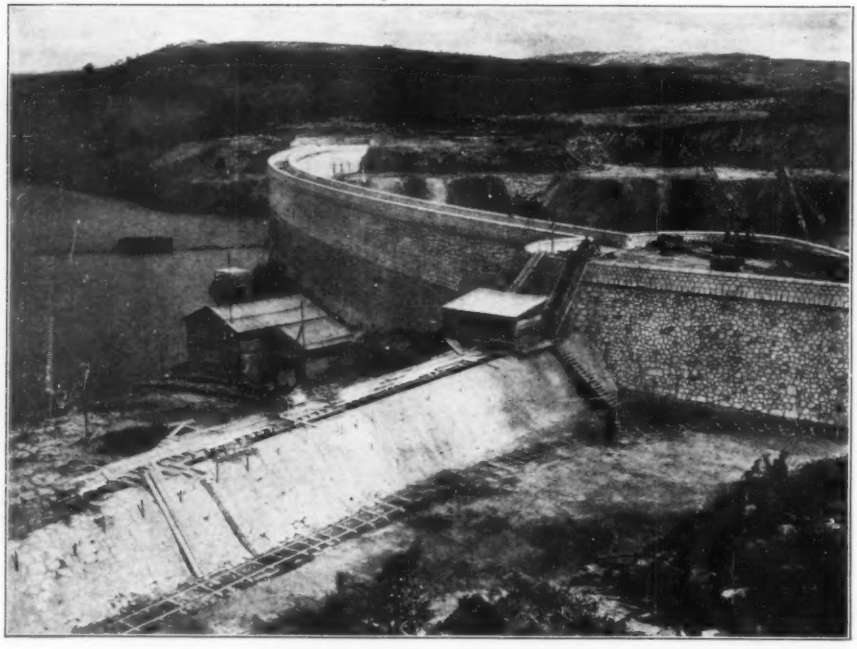
The frequency with which the indicator lamp goes on and off shows the traffic density for a particular lane. At the end of a working period, the number of tolls recorded by the cash registers must check with the count shown by the cell-operated registers.

The wires that are connected to the photoelectric cells are carefully shielded from all external electrical disturbances and carried underground to the operating panel located in the toll supervisor's office. The cells are so located in the roadbed as to minimize the effect of mechanical vibration due to passing vehicles, and so shielded as not to be interfered with by outside lights. This task of protecting the cells was particularly difficult because they are in the open and because the current through them is rated in millionths of an ampere.



The toll supervisor sits before the panel-board in his office hundreds of feet from the toll sheds and keeps close tab on the movement of traffic

The photoelectric cell in the roadbed and the light source overhead



Upstream face of the Marathon Dam showing, in the foreground, the spillway under construction

Water Runs From Marathon to Athens

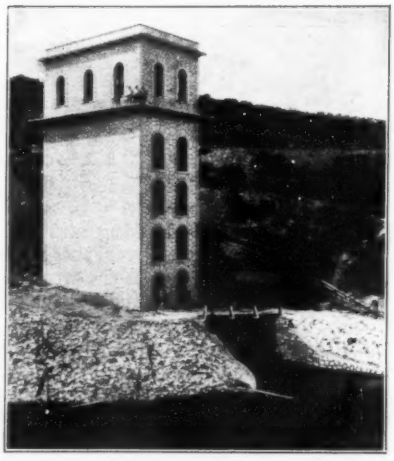
By F. D. McHugh

ABOUT four miles from the plains of Marathon where, in 490 B.C., the combined forces of Athenians and Plataeans numbering perhaps 10,000, won a decisive and famous victory over an invading force of approximately 50,000 Persians, a celebration of unusual importance took place last October in the presence of a large gathering including the Greek President, the Premier, and other notables. The occasion was the dedication of the Marathon Dam, construction of which had just been completed by Ulen and Company, an American engineering firm.

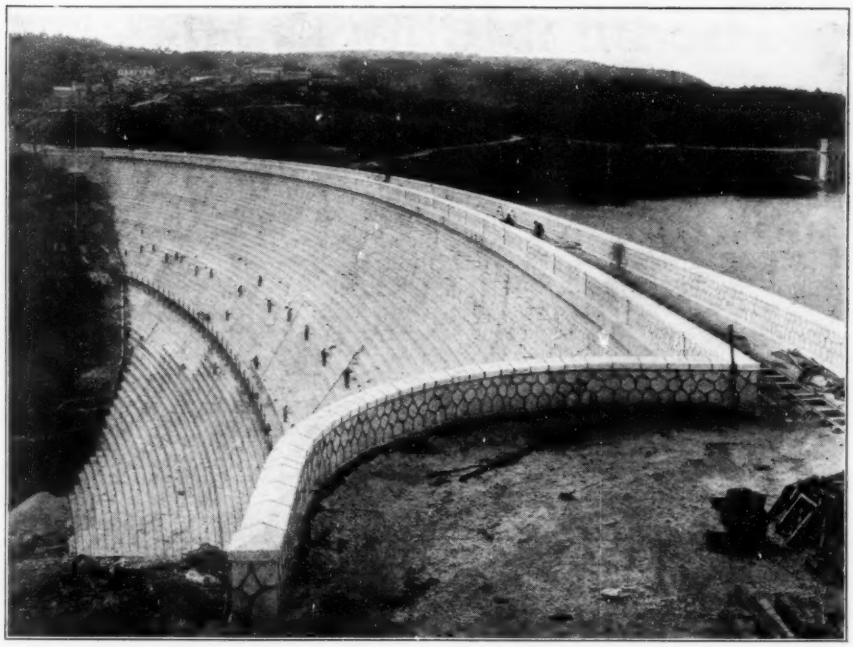
AS dams go, this new one presents no striking departure in construction, and in respect to size, it is far from outstanding. Its bid for fame rests upon the facts that it is practically a mass of marble, that water from it is carried through a 1900-year-old aqueduct, that it is situated in a region rich in historical associations, and that it is an important part of a very important project. Its completion marks the first big step of a plan, costing upwards of 11,000,000 dollars, to solve the age-old problem of providing an adequate supply of water for the city of Athens and environs.

One of the oldest cities of the world, Athens has been sorely pressed for water since its foundation on the sacred rock in 1259 B.C. So dry, in fact, has the Attic region always been that Aristophanes, Strabon, and Pausanias commented upon it in their writings. During Athens' early days, local springs, like the Kalirhoe with its nine spouts (Enneakrounos) and wells like the Klepsydra on the Acropolis, formed the only source of water supply. In time, the underground waters of Mount Hymettus were carried in subterranean aqueducts to the city. Yet the supply was still inadequate for, in 594 B.C., Solon found it necessary to enact strict laws regulating its use.

With the decline of ancient Greece, the Romans tackled the problem and solved it by constructing the famous Hadrian Aqueduct about 115-130 A.D. This



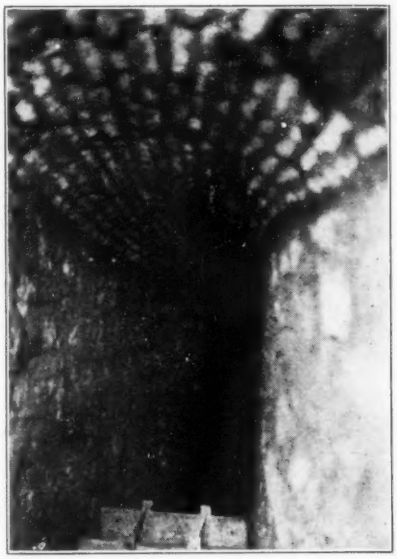
The intake tower to the water tunnel is shown in the upper illustration and in the lower one which also shows the south approach to the dam's crest



Downstream face of dam from north end showing intake tower to tunnel at extreme right and men giving the marble a final cleaning

system brought water from the Pentelicon and Parnes ranges and for centuries the supply was adequate. Invasions of Goths, Vandals, and Slavs then came one after the other, and finally the country was occupied by the Turks. Amid the confusion caused by these disturbances, the aqueduct began to crumble, gradually fell into disuse, and was forgotten. Rediscovered in 1840 it was repaired and became the city's chief source of supply.

With the destruction of Smyrna in 1922 by the Turks and the driving of all Greek nationals from the territory, refugees crowded into Athens. As its population of 300,000 increased almost overnight to 800,000, the question of water supply again became acute. The government at once began consideration of various schemes and the "Marathon Project" was finally decided upon. Of this project, the Marathon Dam is the major part. Its water will flow by gravity to a storage reservoir on the Attic Plain near Athens and will be distributed from there. A secondary and separate part of the scheme is the 23½-mile pipe line through which sea water is pumped from historic Phaleron Bay for sprinkling the streets. The use of this salt water makes available more than 130,000 gallons of potable water daily—water which was formerly used for street sprinkling. Rehabilitation of existing systems was included in the provisional contract which the Hellenic Republic signed, work on which has now been completed and accepted by the government. It is expected that the entire scheme will be complete in 1931.



◄ Interior view of ancient Hadrian Aqueduct, repaired and enlarged

▼ Laying 36-inch siphon line to Athens. Ruins of the old Roman aqueduct may be seen at right

The Marathon Dam is a gravity section structure but was built on an arc radius of 1312 feet, is 174 feet high and almost 1000 feet wide along its crest. A spillway for the overflow was cut into the hill at the south end, and through its base are pipes for completely draining the lake.

WORK was begun in January, 1927, and the first concrete poured 11 months later. As has been noted, no extraordinary engineering problem was presented, but the material used in the dam is unusual. It is faced, on both the upstream and downstream sides, with Pentelic marble from the quarries nearby from which marble was taken for the famous buildings and sculptures of ancient Greece. This facing is laid in a beautiful mosaic of marble blocks in cement mortar so that the effect is very nearly that of a giant honeycomb. It is said to be the only mosaic marble-faced dam in the world. Even the sand and aggregates used in the concrete filling were ground from the same marble.

The old Hadrian Aqueduct was enlarged and repaired at several places for carrying water in this new system, and portions were extended to carry a supplemental supply.

The Pilot 'Phones His Airport Via Radio

By Harold Crary

Edmund T. Allen, who tells here of a pilot's experience with radio in an airplane

THE urgent need for radio equipment on aircraft has long been recognized by authorities in the air transportation business. With larger patronage of airmail and express, and demand for rigid adherence to schedules—and uncertain or bad weather is the chief foe of schedules—and with rapid branching out into passenger-carrying activities, the operators bend every energy to get workable radiophone equipment.

In the past, it has been necessary for the pilot to take off and fly into weather about which he knew practically nothing because it was constantly changing. Also the management was completely out of touch with the craft until it appeared at the terminal field or was forced to return due to the bad weather. If the airplane did not appear after a reasonable time had elapsed, a search had to be organized to comb the country for hundreds of miles to locate the scene of the forced landing.

Now several leading lines have authorized expenditures for necessary ground radiophone stations, hiring of operating personnel, and installation of equipment in the planes. Of these lines, the Boeing System carries passengers as well as mail, and its large-scale operations made it necessary to utilize every known aid to aircraft. Consequently it worked vigorously to perfect the radiophone. The initial use of the radiophone leads to the following positive conclusions as to its benefits:

It adds much to the safety of flying; reduces number of emergency landings due to uncertainty as to weather ahead; enables pilots on regular routes to complete a larger number of scheduled trips on time; and increases the pay load of mail, express, and passengers by reducing the amount of excess gasoline now carried to give the pilot ample cruising radius when he is uncertain as to weather. The radiophone is also of considerable value in dispatching planes and giving orders to pilots in the air.

Edmund T. Allen, whose 6000 hours in the air have included 4000 hours with the airmail, both night and day flying, on the transcontinental route, describes talking to a radio telephone station 150 miles away and several thousand feet "down" in this way:

"'HELLO, Ed!' It is the voice of the Boeing superintendent in my ear phones. 'We have 1100-foot ceiling over the airport. Visibility five miles, barometer slightly below normal, but steady; no change in 30 minutes. Where are you?'

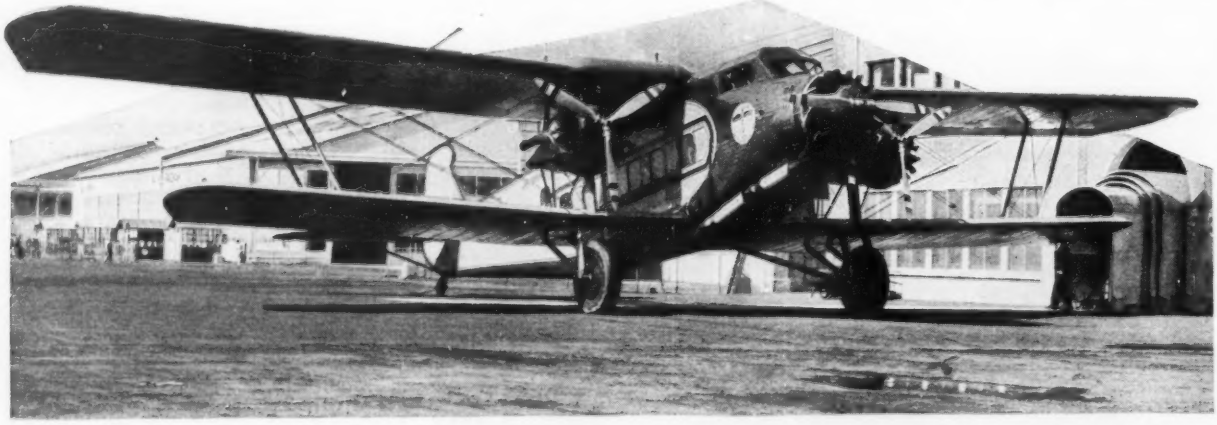
"'Thirty miles out and making 115 miles per hour ground speed. How's the weather half way between here and there?'

"'Same as here,' he answers. 'Fog begins at Summit and ceiling rises as mountains drop away. You are five miles south of the course. We will send up a yellow parachute flare when you arrive within three miles of us. What is the altitude at the top of the cloud layer?'

"'Eighty-eight hundred,' I tell him. 'That gives 1500 feet thickness. Will arrive about 9:13. Shoot rocket at 9:11. Send it vertical to give me exact location. I will jazz my motor on the way down. Listen for it and tell me if I am overshooting. Where is the second section?'

"'John is 70 minutes behind you and is still talking with the other terminal. First section of the westbound is due about same time as you are. Have instructed him to slow down and stay away from the airport until you are down and we tell him to come in. You are still a little south of the course. Five degrees more to the left ought to bring you right over us.'"

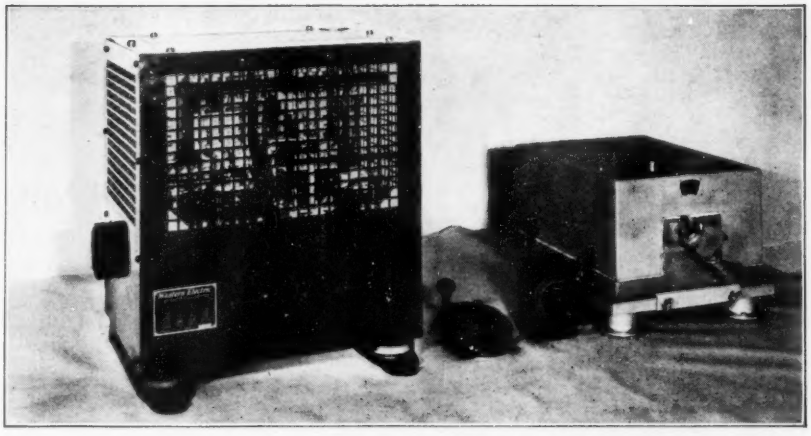
When asked how important he regarded the radio telephone, Allen said, "Instead of flying into the unknown and meeting shifting weather con-



Passengers who board this 18-passenger tri-motored plane, operating on a 20-hour schedule between Chicago and San Francisco, know that their pilot will have continuous radio communication with ground stations

ditions single handed and without adequate information, the pilot will be maintaining uninterrupted contact with the broadcast voice of the radio.

"He may, for example, speak into the mouthpiece which unobtrusively rides in front of his lips: 'Calling Cheyenne Boeing Station—Number 12 reporting passing Elk Mountain point 106. Fog and snow coming in across course from Medicine Bow range. Fog forming along Union Pacific tracks in Rock River sector. Looks clear to north. Ceiling here 1500 feet, visibility five miles. Snow blowing on ground so badly weather station may say zero ceiling and visibility. What is weather in Laramie? Would you advise crossing Sherman Mountains north of the course and coming into Cheyenne from north?' And instantly comes a detailed answer to all his questions through his ear phones."



Above: **The radio equipment that is installed on a plane. From left to right is the transmitter, tuning instruments, and receiver.** ***Left:*** **The tuner. The knob can be operated even with heavy gloves on**

ON one of the occasions when Lindbergh jumped from his airmail plane near Chicago after attempting to find the Chicago airport through the clouds, the field crew heard his motor overhead and knew that if they could but talk to the pilot, they could have brought him in as easily as a passenger train is threaded through the switching yards to the terminal station.

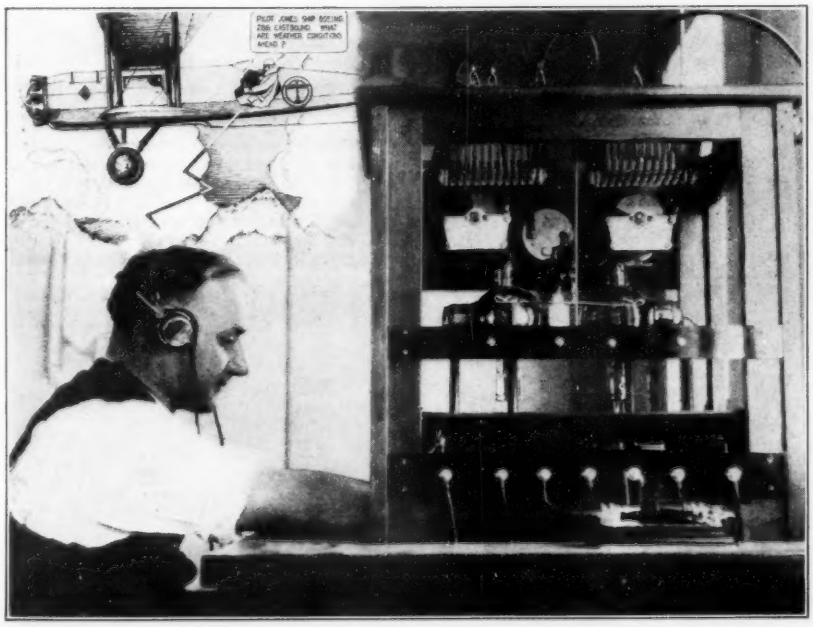
For the pilot, the operation and mechanism of the new radiophone are nearly automatic. He speaks in a normal voice and listens to the reply without the intervention of a radio operator aboard to give him the messages second hand. He can easily control the loudness of either the radio beacon signal or the voice reception as he comes nearer the station, or he can listen to both at the same time, making one or the other louder, as he desires. Boeing pilots have received clearly at 200 miles from the control station and 12,000 feet altitude, and even greater range is expected.

Since the equipment requires no careful adjusting on the part of the pilot, his full attention can be directed to the operation of his engine and keeping the airplane on its course. Added weight and space, which would be necessary for a special radio operator on the plane, ruled out any apparatus requiring expert manipulation in flight or the services of a special operator.

In the equipment, radio cases are mounted behind the pilot with remote controls on the instrument board. With a single throw of a switch, the pilot can change from transmission to reception. All that is required then, is for him to talk into the microphone mounted on his helmet directly in front of his lips.

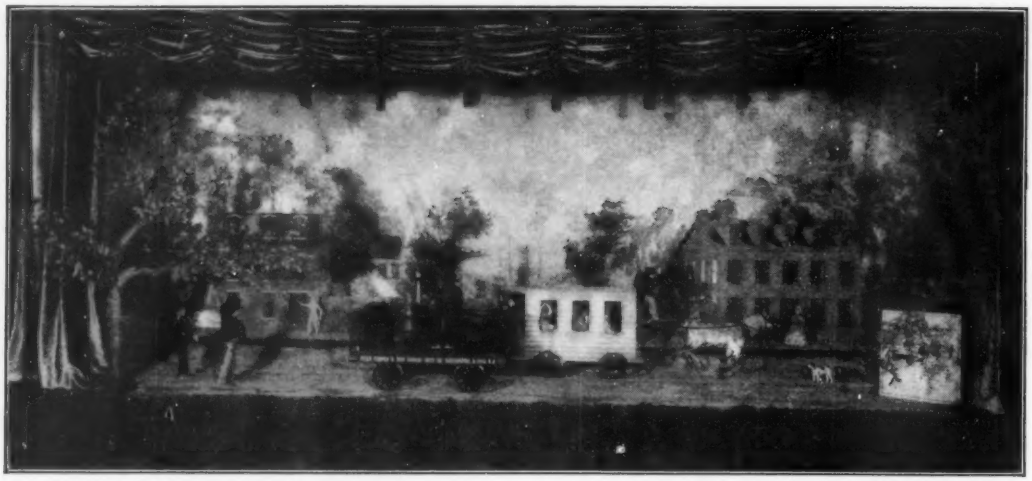
TINY, soft rubber plugs, with "phonettes" attached, fit comfortably in his ears and are connected to the receiver with a fine silk cord. Thus, the pilot, if flying through a snowstorm where constant vigilance is required, will have to give no thought to the radio apparatus.

Now the United States can lay claim to the longest line in the world giving night and day passenger service, with planes having voice communication with the ground and with other planes in flight. In Europe, most of the radio sets require an operator using the Morse code. In the setup discussed here, the pilot simply talks to the nearest ground station, of which there are 14 between San Francisco and Chicago and nine between Los Angeles and Seattle. Either night or day, over plain or mountain, the pilots of the eight-ton passenger transports now place reliance on instructions 'phoned up from the ground station by men who, with the aid of reports received from weather observers on and off the line, can tell the pilot what kind of weather he will run into before he gets to the terminal port.



There are 14 ground stations, such as this one, between Chicago and San Francisco. The pilots are never more than 100 miles distant from one of them

¶ *A coming article will describe how archeologists, under the direction of Mussolini, have found ancient Roman buildings by tearing out the walls of modern structures.*



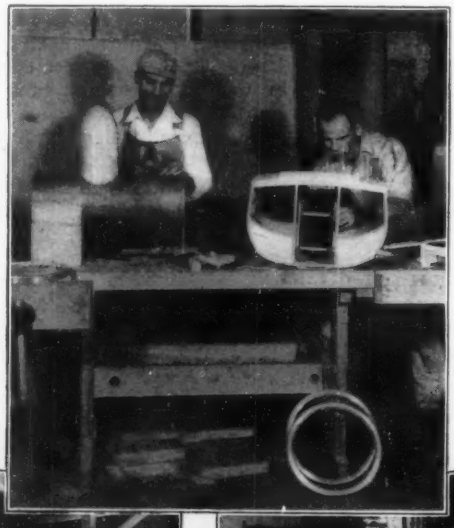
This tableau depicts the famous race between the "Tom Thumb" locomotive and the old gray mare drawing a single coach. The race took place between Baltimore and Ellicott's Mills on August 30, 1830. The rails are made of wood faced with steel. The costumes of the eight men and eight women are accurate to the last button. The horse won owing to "belt failure"

A World in Miniature

WAY down in "Chelsea Village," New York City, in an old armory is a shop which would be the delight of both the museum director and the child. Here are made camels that almost walk, monkeys that play cards—and cheat, dogs that fight for bologna links, and dolls nine feet tall. Who requires such peculiar merchandise? Department stores, pageants, fairs, children's barber shops, and dozens of others. This shop was an important factor in the "Iron Horse Fair." Here is made anything in papier mache, wood, or metal, which can be endowed with motion. We were recently invited to inspect a series of eleven miniature groups illustrating the history of transportation which were made at an expense of 150,000 dollars. The time required was one year, eight months.

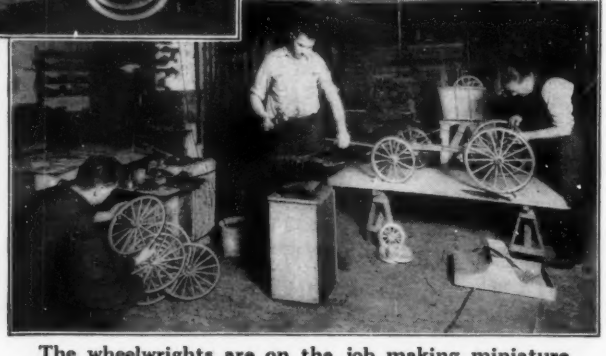
We were particularly struck with the rare fidelity with which detail was handled. Think of trying to get fabrics for diminutive men's clothing and women's dresses of the period of 1830. Ancient "deposits" of textiles were uncovered and utilized. The literature of transportation and every avenue of knowledge was put under contribution, and the result is so worth while that we are presenting a series of illustrations showing how it was done.

The groups are 12 feet long and six feet deep, just right size for a show window. The "ground" is a rubber composition which cannot be damaged by rolling. The whole series of groups can be packed in special water-proof cases. They can all be transported on a trailer 23½ feet long, 7 feet wide by 7 feet high, inside measurements. The groups are intended for exhibition in stores, automobile salerooms, and other places where an educational exhibit is deemed worth while. The groups are so expensive to fabricate that they could hardly be purchased, except by museums. A "Deadwood" coach would cost 5000



Coach makers and boiler makers are plying their respective trades. The coach is a marvel of skill and patience. Every cushion is beautifully fashioned and the springs are accurate reductions. Every rivet in the *DeWitt Clinton* is real

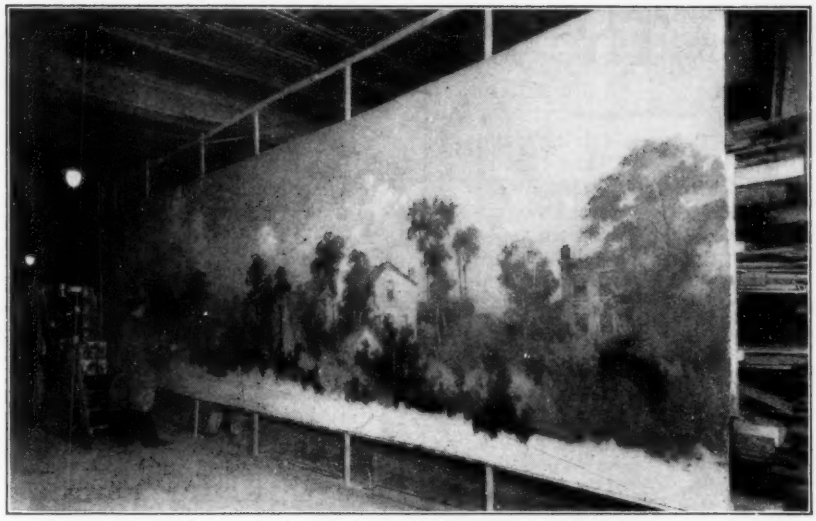
The saddler's trade is a vanishing one. This man makes wonderful saddles, harness, curtains, and cushions



The wheelwrights are on the job making miniature coach and wagon wheels as well as the running gear

dollars and the *DeWitt Clinton* locomotive as much more.

The groups of this particular exhibition are as follows: The Indian Pony Drag, the Conestoga wagon (this great prairie schooner passed its 100th birthday a few weeks ago), Fulton's *Clermont*, the *Tom Thumb* locomotive on the Baltimore and Ohio Railroad, the *DeWitt Clinton* locomotive, the Deadwood Coach, the Pony Express with Buffalo Bill, Lincoln in his carriage, the race betwen the *Natchez* and the *Robert E. Lee*, the Selden automobile, the Wright airplane at Kitty Hawk.



The scenic artist is painting the background for one of the scenes. It is a compromise art between easel picture painting and scene painting. The handling of the various backgrounds helps along the illusion of reality

THE backgrounds were painted by real artists, the designs being made by Mr. Joseph Damon of Messmore and Damon, whose unique shop we are illustrating. Then began the correlation of industries and trades some of which are all but extinct. The coach maker used the care that was expended on a Brewster body. Every bolt and nut and every cushion was reproduced with absolute fidelity. The coppersmith made the boiler for the *DeWitt Clinton*, reproducing every rivet. When the tender was being made, it was found that the floor had been made with the rivets in the frame parallel instead of staggered as they should be. *Crash!* it went into the brass junk barrel and a new one was made with the rivets properly disposed. Probably only two or three persons in the United States, amateur model makers, would have noticed the difference.

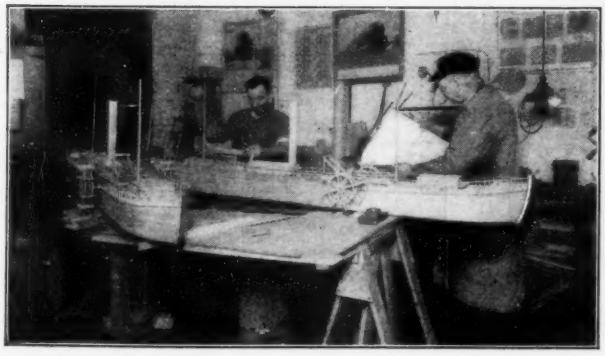
Meantime, the wheelwrights had been making the miniature wheels and the saddler had been spending days on the harness or the hood for Lincoln's state carriage. Not far away, the blacksmith had been making the springs, leaf by leaf, and the woodcarver was making the little wooden figures, for there is no composition or papier mache used here. Meantime, the wigmaker was weaving each hair into a silk foundation and the dressmaker was making poke bonnets, hoop skirts, and men's coats from material from a celebrated Chicago collection.

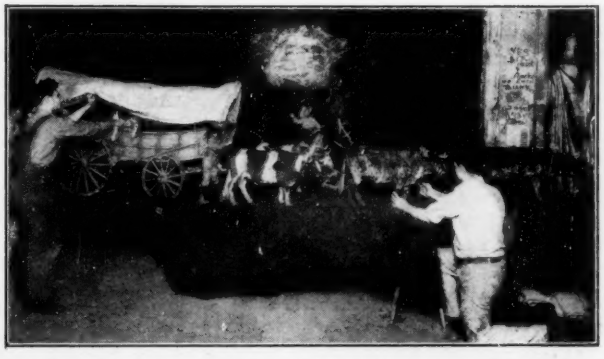
The woodcarver is also a sculptor. It took him a week to carve the head of Lincoln for the lifelike scene where the martyred President is driving. The woodcarver makes many of the accessories

The shipbuilders have been busy on their steamboats, and the sign painters are getting ready to paint the names on the paddle boxes, with the names of the company on the curve. Even such details as this required considerable search in a library where at last an early lithograph was found which gave the desired facts. Other workmen have been cutting little sticks for the fuel for the *DeWitt Clinton*, and "smoke" for the racing steamboat is supplied by mineral wool. The horses shy at the new fangled Selden automobile and it is no wonder, for it is a fearful and wonderful contraption. Nearby, the Wright Brothers are getting ready to fly 852 feet in 59 seconds. Twenty-six and one-third years later, Mr. and Mrs. Lindbergh crossed the continent, making the trip of 2100 miles in 13¾ hours at altitudes of 14,000 to 15,500 feet.

"The Story of Transportation in America," is what the show is called.

The *Clermont* will soon take the water. The model is really a monument to patience. Even the smallest detail is worked out with the greatest possible care





The Conestoga wagon was destined to carry pioneers across the continent. Its centenary has just been celebrated. Here we have the last finishing touches

The Physical Nature of Death*

By George W. Crile, M. D.,
Marie Telkes, Ph. D.,
AND
Amy F. Rowland., M. A.†

THE terms "living" and "non-living" and "dead" denote variations in energy and form. In structure the living organism is identical with the non-living—just as the live battery is identical in structure with the dead battery. But what is the essential feature in the living organism upon which structure depends? What is lost in death?

Thirty-five years ago I first attempted to approach this problem by an investigation of the basis of death. Phenomenon after phenomenon associated with death was critically examined and set aside as it was found to be a result rather than a final cause of death.

Studies of the circulation and respiration showed that the changes in these vital phenomena which are present in exhaustion and death are end effects and not primary causes of death. So, too, studies of the chemistry of the blood, while they revealed that the acid-alkali balance of the organism is of vital significance, did not reveal the cause of death.

RESUSCITATION experiments were performed in which it was found that in normal animals after complete cessation of the circulation for from five to seven and a half minutes, resuscitation followed the infusion of adrenalin into an artery; in the course of these experiments the sequence in the return of the various functions and reflexes was observed. But these experiments, important as they were, did not reveal the cause of the cessation of circulation and of the final death which would have followed had not the dose of adrenalin been administered.

By the examination of great numbers of cells under the microscope we found that certain histologic changes were invariably present in the cells of the brain and of the liver after death from any but sudden and accidental causes. The nuclear-cytoplasmic relation was disturbed and the semipermeable membranes were in process of disintegration. That life was incompatible with such a condition of the cells was obvious but was the condition of the cells in itself the actual immediate cause of death?

Later we directed our investigation to the determination of certain physical constants in various vital and lethal conditions. We found that the processes leading to death were always accompanied by a decrease in the conductivity of the brain and of other components of the central nervous system, and by an increase in the conductivity of the liver with corresponding changes in the electric capacity of the cells. But certainly a change in the conductivity and capacity could not be the immediate cause of death.

Death may result from many diverse causes: from hemorrhage, from physical injury, from infection, from insomnia, from anesthesia, from asphyxia, from surgical shock, from the excision of certain organs—any of these agents alone may produce death, or death may be due to a combination of any of these different factors. Thus in war a soldier may die not as the result of wound alone, or infection alone, or insomnia alone, or anesthesia alone but as the result of a combination of all these various factors. But whatever the cause of death the phenomena of death are identical.

In death the energy characteristic of life is lost—the dead body is in equilibrium. In death the living structures, namely, the cells, are unable to hold their form and structure and inevitably disintegrate. In death the delicate organic molecules such as the fatty-acid chains lose an organizing, binding influence and they too disintegrate.

WE propose now to offer new experimental evidence which identifies a form of energy that is lost in death—a form that is capable of constructing the films and of holding together the essential organic molecules.

These researches which have been carried out in the research laboratories of the Cleveland Clinic Foundation were directed toward finding the relation between electrical potential and oxidation; that is, toward determining whether one or the other is the primary factor in the maintenance of life and whether the loss of one or the other is the essential factor in the production of death or whether both together are primarily essential. Our researches were especially directed toward the discovery of the influence of potential on oxidation; the influence of potential

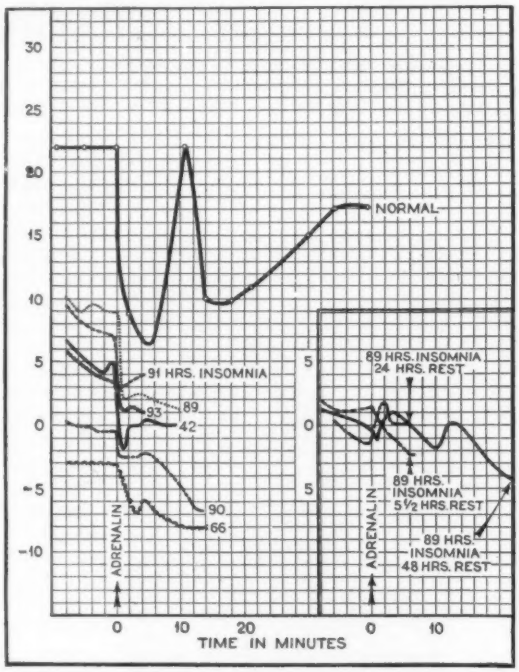


Figure 1: **Effect of insomnia on the potential of brains of rabbits. Note diminished response to adrenalin in the insomnia rabbits**

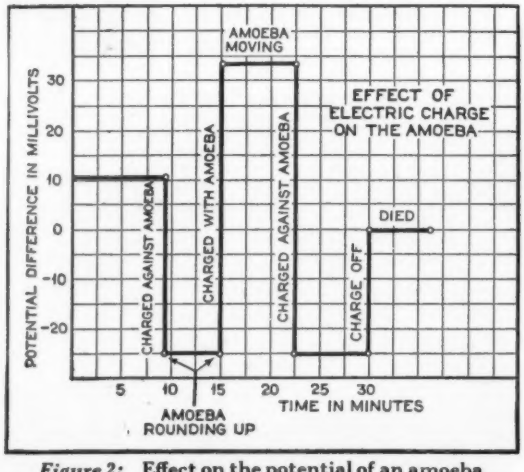


Figure 2: **Effect on the potential of an amoeba of direct and of counter electric charges**

*A paper presented before the American Philosophical Society and reprinted by permission, from the *Proceedings* of that society, which was founded 1727 by Benjamin Franklin.

†See "Among our Contributors," page 5.

on the form of the living, and by inference on the maintenance of the organic molecules; and to the discovery of the relation of the potential to death.

The results of these researches may be summarized as follows:

1. In animals, plants, and fruits an electric potential exists during life and disappears at death.

2. The potential is varied by insomnia, by anesthetics, by poisons, by hemorrhage, by asphyxia, by change in electrolytic solution, by adrenalin, by injury, by heat, and by cold.

3. At the moment of clinical death the potential difference between different organs drops to zero for a few moments; following this, each organ regains its potential for a short time, but finally the potential of all tissues drops to zero, the respiration of the tissues stops, and molecular disintegration sets in.

ARE we then correct in ascribing the cause of clinical death to the fall in the potential between the different tissues, and the cause of the death of single cells or of tissue cultures to the fall in the potential on the cell membrane?

Of primary importance was our finding that insomnia by itself alone produces a progressive loss of potential. In our experiments, if insomnia was sufficiently protracted, the potential declined to zero and the animal died. As the potential approached zero, recovery of potential followed a sufficiently prolonged period of sleep and of rest. Of special significance was the fact that after prolonged insomnia the animal did not respond in normal fashion to the injection of adrenalin. (Figure 1.)

If the molecular structure depends upon an electric strain or potential which also enables the organism to function and grow, we must find direct evidence therefor. Happily we found such direct evidence in observations of the potential of an amoeba. Dr. Telkes designed and constructed an electrode which could be inserted into an amoeba and with this electrode she made measurements of its potential. She found that the potential of the amoeba ranges as high as 15 millivolts and that it changes with alterations in the concentration of the electrolytic solution in which it is immersed, with changes in temperature, and when anesthetics are added to the suspending solution. Radiation, adrenalin, and sodium iodid all induce characteristic changes comparable to those seen in rabbits and in dogs.

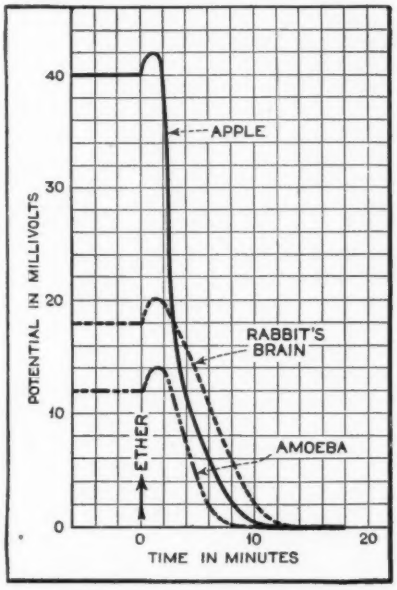


Figure 4: **Effect of ether on potential of apple, brain of rabbit, and an amoeba—again, same effect**

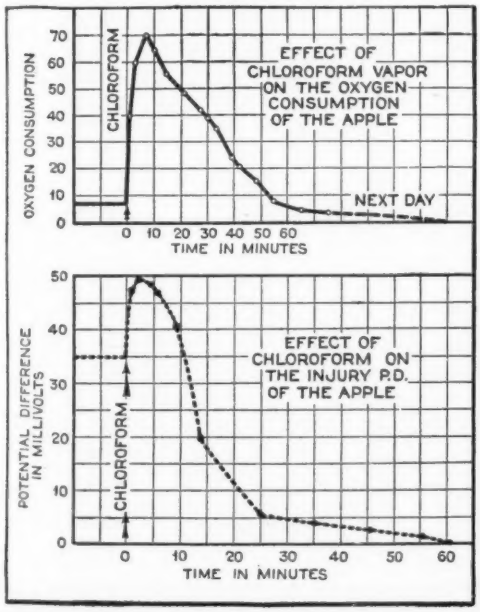


Figure 5: **How chloroform affected the potential difference of apples—again an initial rise, followed by a steady drop to zero**

The amoeba was observed under the microscope during the experiments. Here we had our first opportunity of noting under the eye the changes in structure which are produced by these various agents. Of special interest and importance were the effects of changes in potential produced by the direct application of an electric charge which could be varied at will. When the charge was increased the potential rose, and the amoeba became more active. On the other hand when the potential was diminished by introducing a current the direction of which was opposed to that in the amoeba, the amoeba progressively became less active and withdrew its pseudopodia;

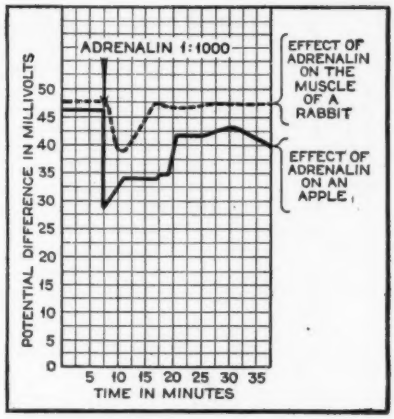


Figure 3: **Effect of adrenalin on the potential of muscle of rabbit (animal) and on potential of an apple (fruit); that is, effect was same**

that is, it rounded up into a quiescent lump, until when the potential reached zero or went over to the negative side the amoeba disintegrated first into larger then into smaller granules and fragments and finally disappeared in the suspending solution. When, however, the potential was lowered by the counter-charge, and by no other factor, nearly to zero and was held there, the amoeba would round up and some granules might even disintegrate; but if at that crucial point when death and disintegration were imminent, the potential was raised by increasing the charge and by nothing else, the amoeba would pass from the resting to the active state, and would again throw out its pseudopodia. (Figure 2.)

This crucial experiment indicates that the fundamental control of the molecular integrity and of the activity of the amoeba—this difference between life and activity and death and dissolution—is governed by the change in the electric potential. In our experiments activity, quiescence, death, and dissolution were governed completely by the production of variations in the potential alone.

FROM this we may infer that the organic molecules that are bound together in the animal organism, the arrangement of crystalloids and colloids, the separation of nucleus and cytoplasm, the maintenance of the molecular organization—we may infer that all these phenomena are manifestations of electric force. Electrical potential is the product of chemical activity and in turn the electrical potential governs chemical activity. These electrical and chemical processes are the governing factors in the production of the phenomena which are characteristic of life. In their absence the organism is dead.

If the organic compounds, structures, and so on, in plants and in animals are created by electric potential and chemical activity, especially by

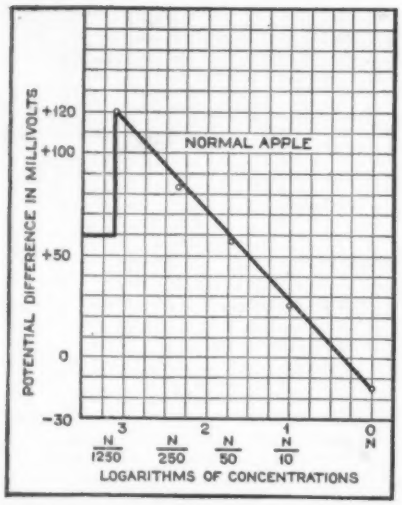


Figure 6: **Logarithmic curve showing effect of varying concentrations of sodium chloride on the potential of a normal apple. The circles represent the five observed values**

oxidation, then in such intermediate forms of life as fruit the same law should hold.

We therefore extended our researches to an investigation of the phenomena of potential and of oxidation in fruit and we found that every kind of fruit has a potential—the potential of an apple, for example, is about 50 millivolts, and the apple has also a steady respiration—consuming from three to four cubic centimeters of oxygen every hour.

In our experiments we found that the potential and the respiration of the apple change in the same direction under the influence of anesthetics, and of changes in electrolytic concentration. The administration of adrenalin, changes in temperature, and the exclusion of oxygen affected the apple just as they affect the rabbit and the dog. (Figure 3.) Anesthetics caused first an "excitant" stage which was indicated by a rise in potential and an increased metabolism; that was followed by a continuous fall of both the potential and the metabolism to the zero point, after which neither potential nor metabolism was again manifested. (Figures 4 and 5.) Adrenalin caused a fall in potential followed by a rise and the respiration of the apple was increased. Changes in electrolytic solutions caused changes in potential which were in conformity with the Nernst formula. (Figure 6.) When the electrolytic concentration equaled the concentration of the electrolytes in the apple the potential fell to zero. Immersing the apple in oil caused the potential and respiration to fall to zero and to remain there. Increasing the temperature of the apple caused the potential and respiration to rise together and after an irregular fluctuation at a given height both fell to zero and remained there.

In all cases in which the potential was reduced to zero the apple disintegrated, just as animals and plants and the amoeba disintegrate when their potential is reduced to zero. A battery was constructed by arranging halves of apples in series and a potential of over a volt was thus created. (Figure 7.)

By this study we have demonstrated that the structure of the apple, like that of the amoeba, is dependent on potential and here again we saw the relation between electric strain and the maintenance of the organic structure.

If oxidation is due to a difference of potential and if living cells are concentration cells, then if apple juice were placed on one side of a celluloid film and distilled water on the other, oxidation and potential should be manifested just as in the apple, amoeba, or rabbit. Such an arrangement was made and as a control another artificial "concentration cell" was set up which was identical with the first, except that a hole was punched in the celluloid film in the control cell. Observations of metabolism and of potential showed that the first artificial cell functioned like the apple and the amoeba; that is, it had a potential and it showed respiration; the control cell, on the other hand, had neither oxidation nor potential.

IN brief, then, in a large series of experiments we have found that in animals and in plants and in fruits there exists a potential which has a certain range during life and disappears at death. This potential is dependent on the presence of a semi-permeable film, on certain electrolytic concentrations, on water, on temperature, on oxidation, all of which together create the organizing potential. It is the charge on the films of the cells which endows the organism with its selective or adaptive property; oxidation occurs only in the presence of an electric charge and the charge is created by oxidation. Life is a phase of the organization created by electric strain or potential and death is an inert stage in which potential is lost and disintegration is inaugurated.

Or we may define life and death in the following terms: Life may be defined as a potential which is maintained and is varied adaptively according to environmental conditions, this potential being maintained by chemical activity—mainly by oxidation. The loss of this potential is death. The principal difference, then, between that potential which is life and the potential which is present in non-living systems like concentration cells is that the living potential is spontaneously and adaptively alterable.

In brief, then, life in the unicellular organism is an adaptively changing difference in potential between the cytoplasm and the medium in which it exists, and presumably between the cytoplasm and the nucleus. In the lowest forms of multi-cellular organisms life is an adaptive difference in potential between the central nervous system and the rest of the organism; in the higher multicellular organisms life is an adaptive difference in potential between the brain and the other organs and tissues, especially the liver. The life of an organ or tissue depends upon the maintenance of a difference of potential between the cells and the intercellular medium, and presumably between the nucleus and the cytoplasm of the individual cells of which it is composed. And in the unicellular and in multicellular organisms alike death is the absence of a difference of potential—final equilibrium.

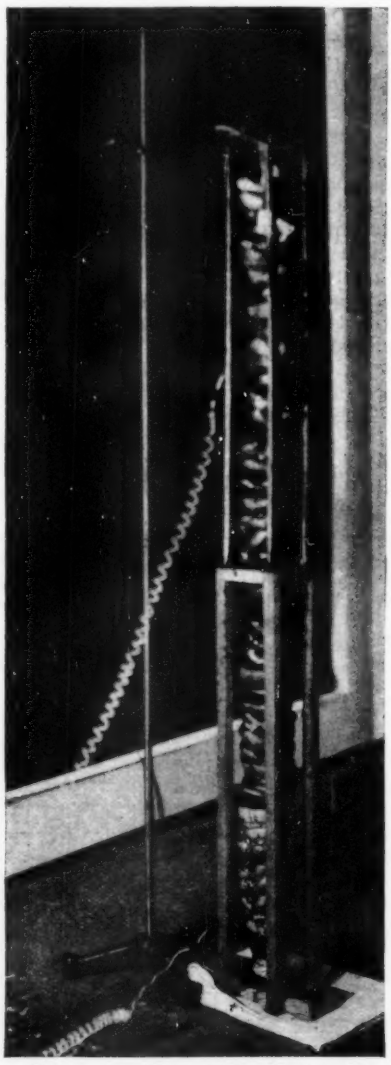
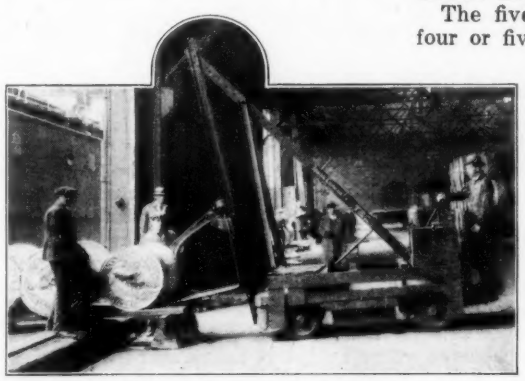


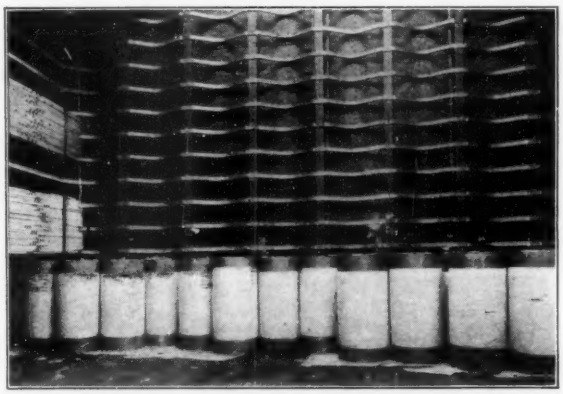
Figure 7: **The apple "battery" made of 50 halves of apples arranged in series. Its potential was more than one volt. The halved apples are piled up in series and electrodes are attached to the bottom and top halves respectively**

Shipping Newsprint Paper in Safety

A CURIOUS craft, the S.S. *Markland*, has been recently making trips from Liverpool, Nova Scotia, to New York at frequent intervals. She was built to perform one duty; namely, to transport 8000 rolls of newsprint paper without chafing or wetting. Of course, paper has been carried by ships from time immemorial but not in this manner. The vessel, which is 336 feet long and of 4454 gross tons, is built on the deep-frame principle. Her cargo holds are constructed with as boxlike formation as possible. All brackets, stanchions, pillars, et cetera, have been omitted and otherwise compensated for. Frames in the cargo holds are continued through the main stringer to the height of the bulwark, with the inner flange of channel removed and watertight collars fitted. The frames are bracketed to the deck. This method of construction compensates for the absence of the ordinary beam brackets usually associated with deep-frame construction, the brackets being eliminated from the hold to obtain better stowage. Frames in cargo holds have steel cargo battens covered with wood to prevent any damage to the newsprint from coming in contact with bare metal. The vertical bulkhead stiffeners support steel strips, wood covered. These strips are so curved as to allow paper rolls to be stowed snugly and firmly between the stiffeners, while the holds forward and aft are boxed vertically in the way of curvatures to allow rolls to be stowed tightly in a vertical position. Wooden battens protect the newsprint from contact with the metal.



The rolls are transferred to trucks by electric tiercing machines



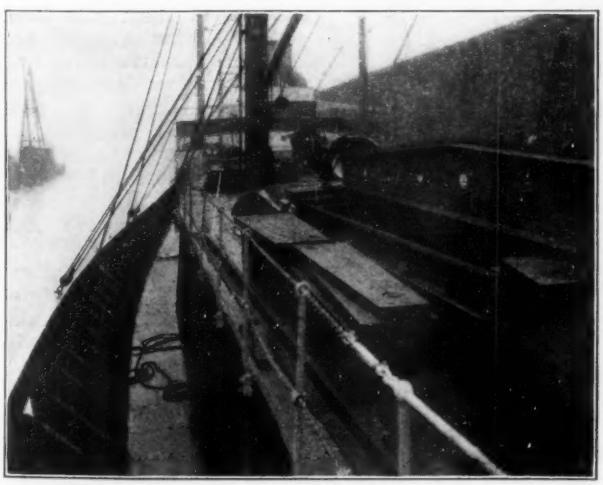
The rolls fit closely. When each tier is complete, painted boards are placed over the top, making a floor for the next tier of rolls of paper

The keel is on the duct principle forward of the machinery space to the fore peak bulkhead to allow steam lines for winches, water pipes, et cetera, to be carried forward clear of cargo holds. The *Markland* was built at Hull, England from the design of Mr. Walter Lambert of Montreal.

The five holds each take care of four or five tiers of paper rolls with painted wooden boards, or "dunnage" separating each tier. Every precaution is taken to avoid danger by water as well as chafing. All pipes are enclosed in other pipes to prevent dripping.

THE regular trip of the *Markland* occupies about 44 hours. Once the pier in New York is reached unloading begins at the rate of 200 tons an hour. The rolls are turned down horizontally and two are swung up through the hatch at one time, the ends of a bridle being inserted in the iron cores. Although hoisted collectively, once on the dock they are handled individually by tiercing machines or trucks which grip one roll at a time, elevating it and carrying it to the waiting truck which when fully loaded, rushes off to carry the paper to the waiting presses.

The pulp wood all comes from Nova Scotia, where the paper is made by the Mersey Paper Company of Liverpool, Nova Scotia. In this plant two paper machines each produce a ribbon of paper 222 inches wide at a speed of 1000 feet a minute.



Steel cargo battens close the five hatches; ten steam winches discharge the paper at a rate of 200 tons an hour

All stanchions, pillars, et cetera, are omitted and they are compensated for by a deep-frame construction

The Mystery of Gypsum Cave

By M. R. Harrington*

Curator, The Southwest Museum
Member, American Anthropological Association

Discoveries Near Boulder Dam Point Either to High Antiquity for Man in America, or to a Later Survival of Certain Extinct Animals Than Heretofore Has Been Believed

IN a deep, dry cavern in the mountain ranges east of Las Vegas, Nevada, overlooking a wide stretch of desert and the distant rugged gorge of Black Canyon—future site of Boulder Dam—an even dozen men and women are trying to unravel a fascinating mystery. This mystery concerns not only America's first human inhabitants, but the strange beasts of a by-gone age.

The workers represent two great institutions, the Southwest Museum of Los Angeles, and the California Institute of Technology working in co-operation, a rare example in this country of archeologists and paleontologists laboring side by side on the solution of a single problem.

I am no stranger to the exploration of caverns, but the first thing I sensed when I first entered Gypsum Cave in 1924 was the mystery of the place. Here was something different, a situation I had never found before.

A little digging near the entrance showed traces of early Pueblo Indians like those who occupied Lost City and Mesa House in the nearby Moapa Valley (both of which have been described in the pages of the SCIENTIFIC AMERICAN[1]) and even of the more recent Piutes. In the rear chambers, however—and the cavern was 300 feet long and 140 feet wide—the only human relics I could find belonged to a much more ancient people, the Basketmakers, who in fact are the oldest inhabitants of our southwest known to archeologists. Reliable authorities even estimate their date as about 1500 B.C.

The Basketmakers are remarkable for the fact that, although they had made a beginning in agriculture, they were ignorant of pottery and knew nothing whatever of the bow and arrow. In fact this weapon which we now consider so typical of the American Indian had not yet, apparently, been introduced into America at all.

Instead of the bow and arrow these ancient people used darts or small spears feathered and pointed somewhat like arrows but longer—about five feet long—and heavier. These were hurled at animals or human foes by means of the curious spear thrower known to archeologists today by its Aztec name of *atlatl*. This was a carved throwing stick about 20 inches long, with a hand hold on one end and a small hook on the other, which engaged a socket or pit drilled into the butt end of each dart. The throwing-stick or *atlatl* in effect added its 20 inches to the length of the user's arm and gave him that much more advantage in velocity when he threw his darts.

In the Pleistocene Epoch ground sloths, some as large as elephants, ranged from California and Pennsylvania to Patagonia. This one is *Nothrotherium*

One of the methods by which archeologists distinguish *atlatl* darts from large arrows is by the fact that the butts of the darts are always provided with these sockets instead of with the notches for the bow-string seen on arrows. I am describing these things here because the Basketmaker relics I found that day in the inner chambers were mainly fragments of such darts.

Now these Basketmaker remains lay on the *surface*. What might lie in the deposits below the surface was an intriguing mystery.

A few test holes revealed the fact that the deposits, upon which the dart fragments lay, consisted very largely of compact manure, reminding me strongly of some old horse corral or barnyard.

This only deepened the mystery, because I could not understand what animal might have existed before the Basketmakers that could have produced such a deposit. I knew that modern horses were introduced into America by the Spaniards, long after Basketmaker days; and that no horses could have penetrated the cave, anyway, on account of its small entrance.

IF Basketmaker dart shafts lay on its surface, the manure must certainly be older than the Basketmakers; that is to say, probably more than 3500 years old. I resolved to return some time and solve the problem, if it was solvable.

However, the Museum of the American Indian, Heye Foundation, with which I was connected at that time, abandoned its Nevada work and I was unable even to visit the cave again until January 1929, when I returned to the region in charge of an expedition from the Southwest Museum of Los Angeles, to work once more in the Moapa Valley.

During the same spring I made several visits to the cave, one of them with Mr. Jesse L. Nusbaum, archeologist for the Department of the Interior, and we both agreed that the manure deposits might well have been left by some animal now extinct, maybe some species of ground sloth, and that the cave should be explored at the first possible moment.

This opinion was strengthened after the close of the expedition when Professor Barnum Brown, of the American Museum of Natural History, examined specimens of the dung. He thought there could be little doubt that some kind of ground sloth was responsible for it, basing his deductions, I believe, on a previous find in South America.

And when the long-hoped-for chance came in January, 1930, to lead out an expedition for the express purpose of

*See "Among Our Contributors," page 5.

[1] "The Lost City of Nevada," M. R. Harrington, July, 1925, pages 14-16; "The Last Stand of the Nevada Pueblos," Irwin Hayden, February, 1930, pages 132-135.

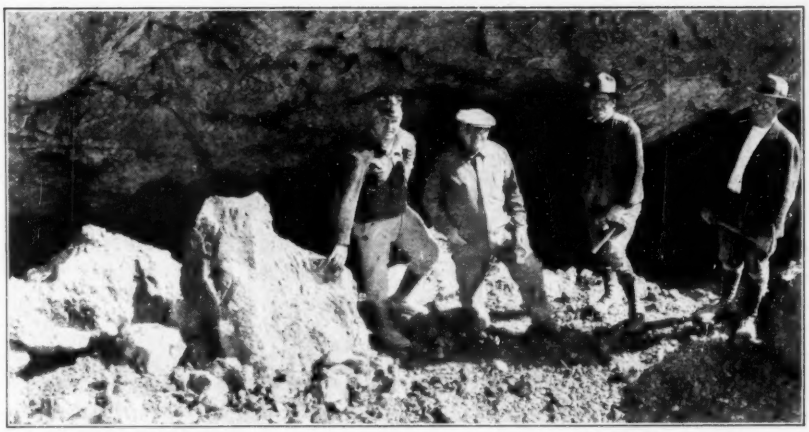
solving the mystery of Gypsum Cave, I was overjoyed. However, I fondly imagined that a few weeks would bring the answer. . . . At this writing 11 weeks have passed, and while we have learned much, the mystery is still a long way from full solution.

Our first task was to examine the surface of the cave floor and all its crannies and crevices as carefully as we could. This resulted in finding, scattered everywhere in the inner rooms of the cavern, hundreds of fragments of wooden and cane dart shafts broken and splintered. Most of them, as were the first ones found in 1924, seemed to be the work of the Basketmakers. There were also countless burnt sticks—the remains of torches.

TWO ancient wooden flutes, some curious bits of archaic basketry, and occasional other relics turned up, including even a few fragments of more modern arrows, but these were as nothing compared to the hundreds of splintered primeval weapons which littered the place. Why were there so many, and why so splintered? The mystery deepened.

Then we found upon the surface among the dart fragments some strange-looking bones, and then my niece, Bertha Parker Pallan, found the unmistakable skull of a ground sloth! We learned later that it belonged to the ungainly species known as *Nothrotherium*, not the largest of the ground sloths by any means, but a creature about the size of a husky brown bear. The skull was not buried; it lay upon the surface protected from view only by an uptilted slab of rock.

Jaws of baby and adult sloths; spear point found near a sloth skull; relics of *Nothrotherium*—hair, ribs, jawbone, and a claw



***Right to left:* Dr. E. L. Furlong and Dr. Chester Stock of California Institute of Technology; Dr. Scherer, Director of Southwest Museum; the author**

Was this really a clue? Our suspicions as to the origin of the manure deposits were strengthened, of course, for we now knew with certainty that the cave had been a sloth den, but what of the darts? Had they been thrown to slay the odd, misshapen beasts of the cave?

Only digging could reveal the answer, and dig we did, starting a trench in the main chamber. Here we found bones—a few of them—some of the mountain sheep, some of a small variety of horse, even a piece of a sloth claw, but nothing made by man.

It seemed a cruel fate that it was not the hard-working trench diggers who made the next big find, but an outsider, or almost an outsider. It was Mrs. Myrtle Evans, wife of one of our Indian helpers, and herself an Indian of the Washoe tribe, who was visiting the cave one afternoon with her little nephew. Scratching with a trowel in a distant end of the cavern she unexpectedly turned out a big bone. It was a sloth vertebra! Soon we had uncovered a large part of the skeleton of a *Nothrotherium*, so well preserved in parts that one great claw still retained it horny covering. Bunches of the long, coarse, tawny hair, with its dark shading, were in perfectly good condition.

In rock crevices near the bones appeared a bit of native string made of yucca fiber and some small feathers wrapped with sinew, possibly part of the decoration of a head dress or perhaps part of a votive prayer stick.

The situation seemed too much for a mere archeologist to handle and I wired for help—paleontological help. In answer, our Museum's director, Dr. James A. B. Scherer, brought to our camp Dr. Chester Stock of the California Institute of Technology, a leading authority on ground sloths, and his associate, Dr. E. L. Furlong. As a result of their visit this institution joined us, and now a joint expedition is laboring in Gypsum Cave. A paleontologist, Mr. J. F. Thurston, is continually on the ground and frequent visits are made by the others.

We have a capable and interested force, including Mr. Charles Amsden of the Southwest Museum, and Mr. Willis Evans, my Pit River Indian friend who worked with me at the Lost City and Lovelock Cave and is now foreman of our laboring crew.

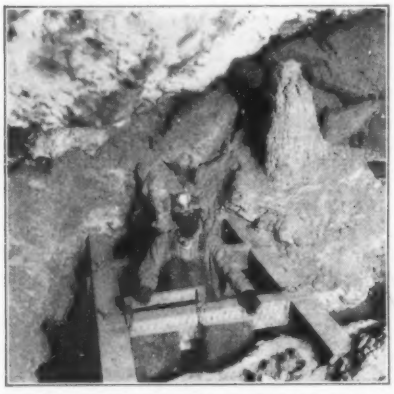
GYPSUM CAVE (named, by the way, for its beautiful crystals of gypsum or selenite) is not easy to explore. This is not only because practically every chamber is cluttered with rock falls, large and small, but principally because the lowest level is 64 feet below the entrance, and the passage from the entrance to the inner chambers is so steep and in places so narrow and tortuous that to carry our tailings or "back dirt" completely out of the cave, as we desire to do, would require a mechanical hoist such as is used in mines, and a lot of blasting. To build such a hoist would require so much outlay of time and money that it would not be justified at present. In consequence, our Zuni Indian workmen are obliged to build huge bins with stone retaining walls, in which to pile the earth and rocks dug from the trenches. Some of these bins will doubtless have to be moved and their contents rehandled when we get ready to explore the cave floor beneath them.

As in a mine, we have found it necessary to timber the roof where it seemed crumbly and in danger of falling; to build cribbing for holding back rockslides that threatened to slip down and engulf us; and even to timber like a mine shaft any pit that

must be driven down into the ground to a depth of more than six or eight feet. All of these operations were new to me, after all my 30 years of archeological delving.

Some days are better than others, but almost every day is adding its bit to our knowledge of the men and the animals of the cave.

On the archeological side we are forming a picture of a people who seem to have visited the cave, long before the Basketmakers, but the portrait so far is little more than an impression. At least we know that the Basketmakers were not the first humans; for, far below the level containing their relics, we have found pieces of dart shafts differing from theirs and cruder. However, these shafts are painted with quite elaborate patterns in red and black, blue and green. We think that the points used on this type of dart were lozenge-shaped rather than notched like the Basketmakers', and were fastened in place with pitch.

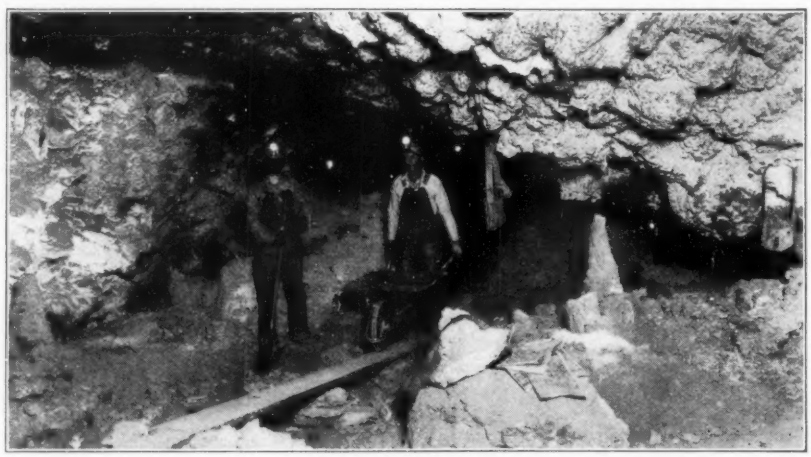


Above: **Mouth of shaft, 12 feet deep. At bottom were found bones of extinct American horses and camels. Near the surface to the right lay most of the ground sloth's skeleton.** *Right:* **Here were found sloth bones and various evidences suggesting that man and sloth existed at the same time**

From the tiny drilled pit on the butt of the dart we surmise that the missile was hurled like those of the Basketmakers, with an *atlatl* or throwing stick, the pin of which fitted into the pit of the dart. We also know that the mysterious "first comers" made these darts of arrow brush stalks and feathered them with whole feathers, instead of the split feathers used by the Basketmakers. From the painted patterns we have some idea of their decorative art, but so far these facts are all we know about them.

If the Basketmaker was not the first human being to leave a record of his presence in the cave, neither was the sloth the first animal. Deep down in the bedded rockfalls and silt of the cave floor, at least ten feet below the level which has yielded most of the traces of the sloth, we have found bones of American horses and camels. In the upper layers other sloth bones have appeared; also more well preserved claws and hair—even the remains of a tiny baby sloth, not much larger than a cat.

But, as for the mystery, which after all may be boiled down to the question, "Did man visit the cave while it was still a den of sloths?" we have no absolutely positive answer as yet. Little by little, however, evidence is accumulating that may some day, we hope, clear away the shadows. For example in Room 1, which is near the entrance and seems to be the only chamber in which the ancients really made their home, we have found a layer, buried under more than eight feet of other deposits, containing large pieces of sloth dung, scattered specks of charcoal telling of ancient fires, and an occasional object made by man. Another bit of evidence is the discovery of some painted *atlatl* darts at depths ranging from eight to 10 feet *beneath* a layer which has yielded dung and hair of the sloth. Still another is the discovery of the lozenge-shaped dart points under the base of the rockslide upon the surface of which lay the sloth skull, only a few feet distant; while in the back chambers in the layers of sloth manure a piece of polished *atlatl* dart imbedded in the manure itself, an occasional burnt stick in the manure and shaft found in the manure had worked its way in through some hole which was afterwards closed again with manure, and that the burned sticks, in spite of their resemblance to the torch sticks found all over the cave, were the result of spontaneous combustion in the manure, some of which is really burned in patches.



BUT so many bits of evidence in so many parts of the cave are rather hard to explain away *in toto*, and it now looks as if, when the mystery is finally cleared, we may find that the sloth, grotesque survivor of an age of monsters, was really seen in the cave by human eyes, and even possibly that the last of his race were slaughtered for food by some of the first "discoverers of America."

But even if the original mystery is cleared up finally and to the satisfaction of all, there will remain, I fear, still another one which is the outgrowth of the first.

If we prove that man and the ground sloths really existed in America at the same time, does that mean that man lived here twenty thousand or thirty thousand years ago—which is the age usually given to the strange society of animals to which the sloth belonged, the mammoth, the dire wolf, the giant lion, and the saber-toothed tiger of Pleistocene days—or does it mean that some of these animals lived on after the glaciers had receded, until comparatively recent times, say up to within ten thousand or fifteen thousand years of our times? The future alone can supply the answer, if any.

sometimes even below it, are certainly interesting in the same connection.

Any one of these bits of evidence might be explained away. One can say that the ancients might have carried the pieces of manure up from the depths of the cave to Room 1 to use as fuel, or that the deposit with the hair and dung covering the painted darts was really older than they, but had slipped down upon them from some point higher up the slope of the cave floor. Or one might say that the skull of the sloth had rolled out of some other hiding place after the lozenge-shaped dart points had been buried. One might even say that the dart

¶ *While this article was in press Dr. Frank Leverett, the widely known glaciologist, described before the National Academy of Sciences the discovery in Equador of human remains, associated with those of a mastodon. This supplies another bit of evidence on the question stated in the above paragraph.*

—The Editor.

The fuselage of the "Waterplane" rises from the water after a run of 150 feet

A "Flying" Outboard Motor Boat

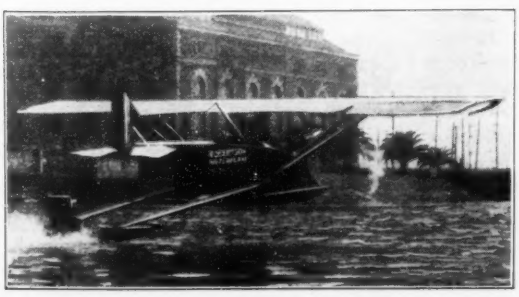
The pilot's right hand is grasping the joy stick, his left the gas control; his feet are on the rudder bar

A NEW water sport that combines the safety of outboard motor boating and the thrills of flying is made possible by the "Waterplane," designed by Russell and Milton Robertson of Alameda, California, after they had repeatedly watched tiny outboard powered racing craft rear their bows out of water. The thought occurred to them: Why not put wings on the boat and lift it completely out of the water?

Essentially the "Waterplane" consists of two units connected together by hinged arms. The rear unit is composed of two pontoons which support a standard four-cylinder outboard motor. The front unit is nothing more nor less than a glider, but in this case it is a glider that does not require a ground crew, being entirely controlled by the pilot. The fuselage of the glider is so constructed that it will float on the water, and can be pushed by the outboard motor. When the proper speed is reached, the pilot manipulates the controls and up in the air goes the glider. The motor stays in the water and continues to furnish the motive power as long as the pilot desires to stay aloft. The glider can reach a height of from 10 to 15 feet above the surface of the water.

Milton Robertson tells of flying a "Waterplane" as follows: "Seated at the controls, the pilot starts the motor by means of the electric self-starter. From a standing start to full flying speed requires a 150-foot run. At first it is best to plane over the surface, getting used to the controls. At about 35 miles per hour, the stick is pulled gently back and the 'Waterplane' leaves the water. At first it took all my attention to navigate but after the first few times aloft, the movements of the stick became automatic. Slowing the motor to a little below flying speed allows the plane to settle gently to the surface."

The glider unit of the "Waterplane" is equipped with the usual controls for ailerons, rudder, and elevators. By proper manipulation of them the pilot can bank on the turns, swoop gracefully from higher to lower altitudes, and get a taste of all of the thrills of actual flight, at the same time literally "keeping one foot on the ground."



Above: A rear view of an open model "Waterplane" about to take off

At left: All the thrills of flying in a "Waterplane" built with an enclosed pilot's cockpit

Waves and Particles*

By Professor George P. Thomson†

Professor of Natural Philosophy in the University of Aberdeen, Scotland
Non-resident Lecturer at Cornell University

The New Concept of the Nature of Matter

IF I break a piece of chalk, then take each of the bits and break them, and so on, is there any theoretical limit to the progress other than that imposed by the coarseness of mechanical appliances? This is a question which has occupied science since the twilight of its earliest dawn.

In the last three or four years opinions have altered as to the best answer to this question. During the first quarter of this century the answer to the question was quite definite. If the piece of chalk is continually broken and rebroken a time comes when the pieces are no longer merely smaller but become different in kind. This stage can not be reached by mechanical breaking, but it can be reached by heat and suitable chemical action. The chalk has been broken into its atoms. In chalk there are three kinds; other substances would yield other kinds, and, in all, chemists have distinguished 90 kinds from which all matter is made.

THESE atoms are small. They bear about the same relation to a drop of water that a drop of water bears to the earth. But even here the limit had not been reached. Towards the end of the 19th Century it had been found possible to break pieces off these atoms: for example, by the violent collision of other atoms. These pieces were always the same. They are called electrons and have now become almost an article of commerce, for they are the working material of the radio valve. The hot filament of the valve gives off electrons as water gives off steam, and the electric forces in the oscillating circuit control the motions of the electrons.

The older view of the electron is best expressed by regarding it as a tiny lump of electricity which had a little mass—less than a thousandth of that of a light atom—as a kind of secondary property of its charge. It was supposed to have a certain extremely minute size, but as a matter of fact the estimate of this size rested on purely theoretical arguments and no one had ever measured it. However, it soon became apparent that each atom contained electrons varying in number from one each to nearly 250 each for different kinds of atoms. Thus it was reasonable to suppose that an electron was a good deal smaller than an atom.

Later on—it is difficult to give an exact date—it became clear that there was a second universal constituent and that this was the residue of a hydrogen atom when one electron—the only one—was removed. It has been called the proton. Every atom contains, in its normal state, an equal number of electrons and protons. The protons are much the heavier of the two, but they occupy only a very small region in the center of the atom called the nucleus. This region is so small that the combined nuclei of a man's body would form a barely visible speck. Since the nucleus also contains some electrons these apparently must be at least equally small, and we are left with a picture of matter as mostly emptiness. That such a view is not purely figurative has been shown in a striking manner recently. It seems certain that some stars known as "white dwarfs" are so dense that a cubic inch would weigh a ton. This is still nothing like the density of a nucleus but it shows at least that an ordinary solid must have plenty of gaps if it can be compressed to such an extent.

Courtesy of *Nature* (London)

In the author's experiment rings were produced on a photographic plate by electrons scattered systematically in passing through a gold film. The pattern is interpreted as due to electron waves. See the text, page 40

The picture of matter was thus essentially one of discontinuity. It consisted of a number of specks—of a whole number, for an electron or proton can not be split. It is a return to the earliest philosophy, for it was Pythagoras who taught that "all is number."

But there was another side of physics in which continuity was supreme. If you had asked the question "How does one electron act on another," the answer would have been "through stresses in the ether." Now the ether has had a long and checkered history. Ethers of a sort were common in early physics—rather too common. But the ether first acquired an assured status in the scientific world when it became clear that light had to be explained as *waves*. As this introduces the other half of the title of my paper you will perhaps allow me to dwell on it in some detail.

The obvious thing about light is that it goes in straight lines—as can be seen if you watch light passing into a darkened room through a small hole and tracing out a path as it lights up the motes of dust. Now Newton said that a particle free from force goes in a straight line. It was natural to suppose that light consisted of a stream of particles shot out by the luminous object. Light can be reflected by mirrors and refracted by glass but, superficially at least, these effects can be explained as a rebounding of the light particles, or their deflection by forces at the surface of the glass, as the case may be. Nevertheless, influential men such as the Dutch physicist Huygens suggested in the 17th Century that light was a form of wave motion. Now sound is wave motion and every one knows that sound will go around corners. So will water waves. How can you explain the rectilinear propagation of light on this view?

It is all a question of the wavelength. Even in sound a high-pitched note is not heard well round a corner. If the wavelength of light is small enough rectilinear propagation is all right. Also light does bend very slightly. The really crucial test is what is called interference, the property by which two lights can produce darkness. A special form of this is to take a number of regular spaced wavelets, all derived from one wave. This gives a peculiarly marked effect. The effects of the combined wavelets are strongly concentrated in a few privileged directions and cancel everywhere else.

LIGHT shows this phenomenon to a very marked extent. For example, in the case of the diffraction grating, light scattered from a large number of regularly spaced scratches on a glass or metal surface is found to be concentrated in a few directions, and this effect can be used to measure the wavelength of light with very great accuracy.

The ether was required to carry these light waves. At first it was thought of as a kind of jelly, and Lord Kelvin used immense mathematical skill in finding the very peculiar type of jelly which alone gives exact agreement with the experimental laws of light. Now Faraday long before had regarded electric and magnetic effects as stresses in a medium, and Maxwell showed that the same medium could do

*From the George Fisher Baker Lecture, delivered at Cornell University, and reprinted by courtesy of *Science*

†See "Among Our Contributors," page 5

double duty—carry electric effects and transmit light. Hertz crowned the theory by actually producing waves by purely electromagnetic processes which had the velocity of light, and in fact were invisible light: "light" whose wavelengths were to be measured in meters instead of thousandths of a millimeter as are those of the visible kind. I need hardly say that these waves are those now used in radio.

Later it was shown—not until 1913 indeed, but logically it comes in here—that X rays are invisible light, on the other side, as it were. Their wavelength is about 10,000 times shorter than that of ordinary light instead of millions of times longer. The way in which this was proved is of interest. To show interference well, one needs an apparatus so exactly shaped that the errors are smaller than the wavelength to be tested. Now X-ray wavelengths are smaller than most atoms. It is impossible to shape an apparatus exact to an atom. Von Laue got over the difficulty in a very ingenious way. He remembered that in a crystal the atoms are arranged in regular order like soldiers drawn up in close formation.

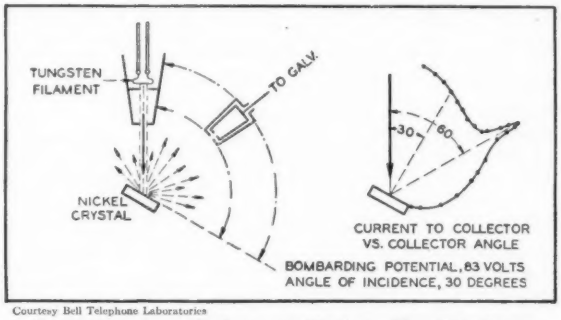
The result is a series of lines like a diffraction grating and about the right distance apart. Actually it is a little more complicated because the atoms are arranged in a solid array, while an ordinary grating is on a plane, but this does not really matter. The result of sending X rays through a crystal is a diffraction pattern, and in this way the wavelengths can be found.

SO far, then, we have matter made of discontinuous particles, while the interaction is due to a continuous medium which can transmit waves. But now came the difficulties. I will take two selected ones which are enough to show their nature. When light is allowed to fall on a polished metal surface, electrons are thrown out from the metal. Since light is electromagnetic waves and electrons are electrical, it is not surprising that there should be an action of this kind, but the details are all wrong. The speed with which the electrons come out does not depend on the intensity of the light. They come out with just the same speed for the feeblest light as for the strongest, only there are fewer of them. Now if, for example, sea waves are breaking on the beach and rolling the pebbles about, the more violent the waves the farther the pebbles are thrown. If the water waves behaved like light, an almost calm sea would throw a few selected pebbles as violently as a great storm throws them all. This is obviously contrary to one's ordinary conception of waves, and it is equally at variance with the results of a complete mathematical treatment. Moreover, the energy with which the selected electrons appear is so great that they would take hours to absorb it from feeble light, while even with the feeblest light there is no detectable lag between switching on the light and the appearance of the electrons. Obviously something is wrong.

Einstein suggested that the light contained units of energy or quanta which behaved practically like particles. When one collides with an electron it gives up its energy to the electron which then can escape from the metal. All the quanta in a given kind of light are the same, but the stronger the light the more numerous they are. The energy of each quantum is the frequency of the light multiplied by a quantity "h," which can be found by measuring the energy of electrons emitted by light of known frequencies. This has been done by Professor Millikan. He finds $h = 6.55 \times 10^{-27}$.

Now this is all very well for the photoelectric effect, as the above is called, but what about the diffraction grating? We have just decided that light must be waves and now it turns out to be particles instead, for it is essential for the explanation that the quanta should be so concentrated that one electron can catch a whole quantum. This is the famous photoelectric paradox.

Before I try to answer it, I will describe the ôther difficulty. Atoms can be made to emit light, and each atom emits its own characteristic wavelengths. These are clearly a consequence of the structure of the particular atom, presumably of the arrangement of its electrons. Now one theory, and one only, was found capable of explaining these wavelengths even in general terms. This was the theory due to Neils Bohr according to which the electrons were supposed to move in orbits 'round the nucleus rather like planets 'round the sun. But in order to make the theory fit the facts, Bohr had to assume a behavior of the electrons which is quite contrary to ordinary dynamics, and curiously enough the same quantity "h" came in, though in quite a different way.



Courtesy Bell Telephone Laboratories

In measuring electron scattering, the "electron gun" at upper left corner sends a steady stream of electrons to the crystal, which scatters them in various directions. The collector (marked "to galvanometer") catches more or fewer electrons according to its position. In the case at right, for example, the maximum number of electrons caught was at 60 degrees angle. This is the principle of the method used by the physicists Davisson and Germer of the Bell Telephone Laboratories

The real trouble was not so much that the electrons obeyed different laws from those of Maxwell and Newton, but that they were not consistent about it. Some of the things they did required the old laws to explain them; others required a new and inconsistent set. Sometimes both had to be used in different parts of the same calculation. The position of a physicist investigating an atom was rather like that of a man trying to make sense of an account of a game which started as golf and suddenly for no apparent reason turned into tennis and then back to golf again. Worse still, as time went on it became clear that the electrons did not play fair even at the game they had for the moment chosen. The results were nearly right but not quite. The only hint was that the quantity "h" came in whenever the atom chose to break the old rules, and this suggested a connection with the photoelectric paradox.

The first really successful attempt to solve these difficulties is due to Prince L. de Broglie. [See SCIENTIFIC AMERICAN, March, 1930, page 183.—*The Editor.*] He realized that the reason why the electron in the atom seemed to follow two different sets of rules at once was that it was behaving much more like a wave than a particle.

NOW if you think that you are reading an account of a game played with a ball, when really the reporter was writing about a swimming match, it is not to be wondered at if the report does not make good sense. It is perhaps surprising that the physicists made as much of it as they did. De Broglie's theory was a mathematical one based on relativity. He reached the conclusion that any moving particle would be accompanied by a wave, and he postulated that this wave controlled the motion of the particle. Instead of Newton's laws of motion (motion in a straight line, acceleration proportional to the force, and so on) this view gives a motion governed by waves. Of course Newton's laws are true in every-day life. This is because a very short wave is indistinguishable in behavior from a particle, and the scale of de Broglie's waves is given by "h," which is a very small quantity.

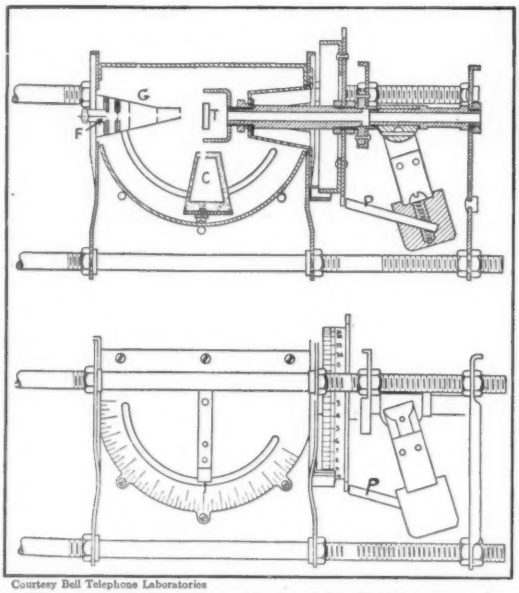
But according to his theory the smaller the particle the longer the wave. For an electron in an atom the wave is quite comparable with the size of the atom, and the behavior of the electron is greatly different from what you would expect of a particle. It has been found in fact that this theory, when fully applied mathematically as it has been by Schrödinger and others, brings order out of chaos in the explanation of the properties of atoms.

Further, it is capable of dealing with the photoelectric paradox. Granting that there are in fact quanta, or particles, in radiation, they will inevitably be accompanied by waves which will guide them. The quota will appear where the waves are strong; where there are many quanta the light will be intense.

IN other words, the regions of brightness and darkness will be just those predicted on the wave theory. This way out had indeed been suggested before. It turns the flank of the difficulty by saying that it is the natural way for a particle to behave. But if you accept this you must be prepared to take the consequences. A free electron, such as a cathode ray, should also be guided by waves and should also show diffraction. How could we hope to detect it if it did? Calculation shows that the wavelength of a free electron of manageable energy is of the same order as that of X rays. Can not we use a method similar to that by which the waves of X rays have been measured and take advantage of the regular structure of crystals?

Successful experiments on these lines have in fact been made by Dr. Davisson and Dr. Germer[1] in this country and by myself and others in Scotland. In my own experiments a narrow beam of fast electrons, cathode rays, in fact, pass through a very thin film of metal. The metal scatters the electrons, and since metals consist of a number of minute crystals, the scattering occurs predominantly in certain privileged directions, just as is the case with X rays. Accordingly, if the electron strikes a photographic plate placed somewhere behind the thin film we should expect to get a pattern similar to that produced by X rays of the same wavelength.

This expectation is in fact realized. I have obtained these diffraction patterns from a considerable number of metals. In all cases the patterns are in exact agreement with what is to be expected if they are regarded as the result of diffraction of waves by the known crystal structure of the particular metal used. The patterns are in general formed of concentric rings just like the familiar Debye-Scheerer X-ray powder photographs. From the sizes of the rings it is possible to deduce the wavelength of the waves causing them, and I find in all cases absolute agreement with the theoretical expression due to de Broglie, $\lambda=h/mv$. Thus instead of being scattered irregularly by the metal, it appears that if the film is thin enough it will guide the electrons into the direction which would be taken up by waves diffracted from the crystal structure of the metal.



Courtesy Bell Telephone Laboratories

The actual apparatus devised by Davisson and Germer for exploring in three dimensions the space surrounding the target *T* of electron gun *G*. Angle of electron collector *C*, may be varied by means of curved slide; also target can be rotated (see dial on lower section drawing of same apparatus). Galvanometer connected to collector *C* registers the number of electrons

If you accept the experiments as showing that electrons behave as if guided by a train of waves, you will agree that de Broglie's idea brings a remarkable simplification. Both electrons and light quanta are on the same footing as particles guided by waves.

The difficulties of physics in the earlier years of this century were due to ignorance of this dual character. For some reason we had got hold of the wave aspect of light and the particle aspect of electrons, and were running each to the exclusion of the complementary view. It also explains the curiously confusing nature of the difficulties. If we had neglected, say, the wave aspect in each case, all the new facts would have pointed to waves. As it was, some pointed to particles, and some, as we now know, to waves.

This dual aspect of things as waves and particles must be very fundamental in the world. There is little doubt that protons would show it also, though experimental proof has so far not been possible[2]. There is even strong, though indirect, evidence that a completed atom has a wave as a whole as well as component waves for its individual electrons. One reason for regarding the duality as really fundamental is that it holds for such different things as electrons and quanta. For in spite of this one point of resemblance they are essentially different. The electron has electric charge and hence is influenced by electric and magnetic forces in a way that the quantum is not. The quantum always goes (*in vacuo*) with a speed of 300,000 kilometers a second. The electron can go with any speed, provided it is less than this. For equal wavelengths the penetrating power is quite different.

These differences make it all the more significant they should both show the same curious duality. The new view is not by any means free from difficulties. To take the most obvious, many electrons form part of each of the atoms of a crystal, yet the experiments I have described essentially involve the idea that the wave of the moving electron is spread over a number of the atoms in the crystal. Have we proved that the part is greater than the whole? I think that even modern physics is not so paradoxical as this. It depends on what you mean by the size of an electron. We can measure the size of atoms in a fairly definite way by finding how many can be packed into a given space of solid. It is rather like measuring the size of shot by counting how many will fill a cartridge case of known volume. Of course we have to allow for possible empty spaces between, but this can be done if we know how they are piled together, and in many cases we do. The sizes are not quite definite; they vary a little with circumstances, but this is not surprising.

SUPPOSE that you want to know the size of a tennis ball. It is easy enough to measure it to an accuracy which will satisfy the authorities at Wimbledon that it is legal, but if you were asked to give its diameter to a hundredth of an inch there would be difficulty. Are you going to measure it to the farthest-out hair of the felt? Obviously that is not a very important measurement, but where are you going to stop? There is no sharp edge. Here a rough measurement has a real and useful meaning, but if you try to make it precise beyond a certain point it can be done only by making some arbitrary convention, such as how hard the

[1] See page 7.

[2] Soon after Dr. Thomson made this prediction it was made good by Professor A. J. Dempster of Ryerson Laboratory, University of Chicago. See our April number, pages 263 and 264.—*The Editor.*

measuring instrument is to press.

This is the case of the atom, but for the electron the size is even less definite. It has not got even an approximate boundary, as far as our present knowledge goes. It is more like a gas which can expand to "fill" (in a sense) any vessel into which it is put, and yet can be compressed into a very small space. When an electron is part of an atom, its waves curl round, as it were, on themselves until it occupies only the atom, and perhaps only a part of that. When it gets free from the atom as a cathode ray, or escapes from the filament of a valve or vacuum tube, its waves can uncurl and expand indefinitely. I think, however, that in all cases one must consider it as also having a sort of center, even if this is only a mathematical point. Whenever an electron produces any detectable effect it does so as a particle, and it seems easiest to suppose that even when it is not producing an effect the particle is somewhere 'round. The best analogy I have been able to find for this view is a gossamer spider.

WHEN this little animal is clinging to the stalk of a plant, it is a small solid object. When it wants to move it shoots out long filaments many times its own length. The wind catches these and wafts it away. I regard the filaments as analogous to the waves which surround the electron, while the body of the spider is analogous to the central point. One can press the analogy further. If the wind carries the spider so that one of its filaments is caught in an obstacle, the spider will be swung around and its path deflected although its body has not hit anything solid.

In just the same way with the electron, if its waves pass over an obstacle, say an atom, the direction is modified and this modification is transmitted back through the wave system to the electron itself. If we suppose that the electron is constrained always to move in a way determined by the waves in its immediate neighborhood, the motion of the electron itself will thus be modified. The waves thus act as a kind of intermediary between the disturbing objects and the electron itself. The electron goes where the waves in its immediate neighborhood carry it, just as the spider is pulled by the parts of the filaments which are actually attached to it. But the form of the waves, near the electron, is determined by events at a distance, whose effects are propagated through space in the form of waves.

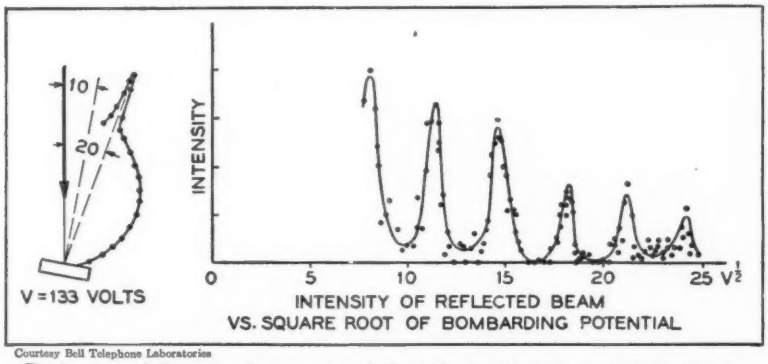
A question that inevitably arises is—what is the medium which transmits electron waves? I am sorry that I can give no entirely satisfactory answer. For the first time, physics is faced with waves in empty space which do not fit into the ordinary series of ether vibrations. All the ether vibrations differ only in wavelength; if the wavelength is given, the kind of "light" is fixed. The electron waves have varying wavelengths, depending on the speed of the electron, but they usually fall in a region of wavelengths which is already appropriated by X rays. As we have seen, they are certainly not the same as X rays. One must suppose some other medium, or at least that the ordinary ether is in some way profoundly modified by the presence of the electron. It is possible that they are waves in a "subether." But it is not a very attractive idea to have two ethers filling space, especially as the waves of protons, if they exist, would demand yet a third. Space is getting overcrowded.

Other suggestions are to regard the waves as a kind of mathematical abstraction, a sort of ghost waves. The whole question is getting very metaphysical. Perhaps a simple physicist may be content as long as the waves do their job of guiding the electron, and it is possible that, after all, the question will ultimately be seen to be meaningless. Whatever the medium is, the new wave conception has altered the view we take of the best answers to the question with which I began this lecture. Matter is still supposed made of discrete units, but instead of these units moving by laws which concern them alone as did the laws of Newtonian dynamics, we have had to introduce laws based on waves. Now a wave is essentially a continuous thing, even if the continuity is only mathematical. It is spread through space, not divided into little lumps. So although the older belief in the discontinuity of matter still holds, it has lost some of its rigidity; continuity has crept in by the back door.

The idea of the ether has also changed. The sole function left it is to guide the quanta; they do the work. The picture of light as waves breaking on a shore of matter, and thus disturbing it, is replaced by one of a stream of bullets which affect only the particular objects which they hit. The bullets, it is true, do not move quite as ordinary bullets would; they are directed by the waves, but all the effects are bullet effects, not wave effects.

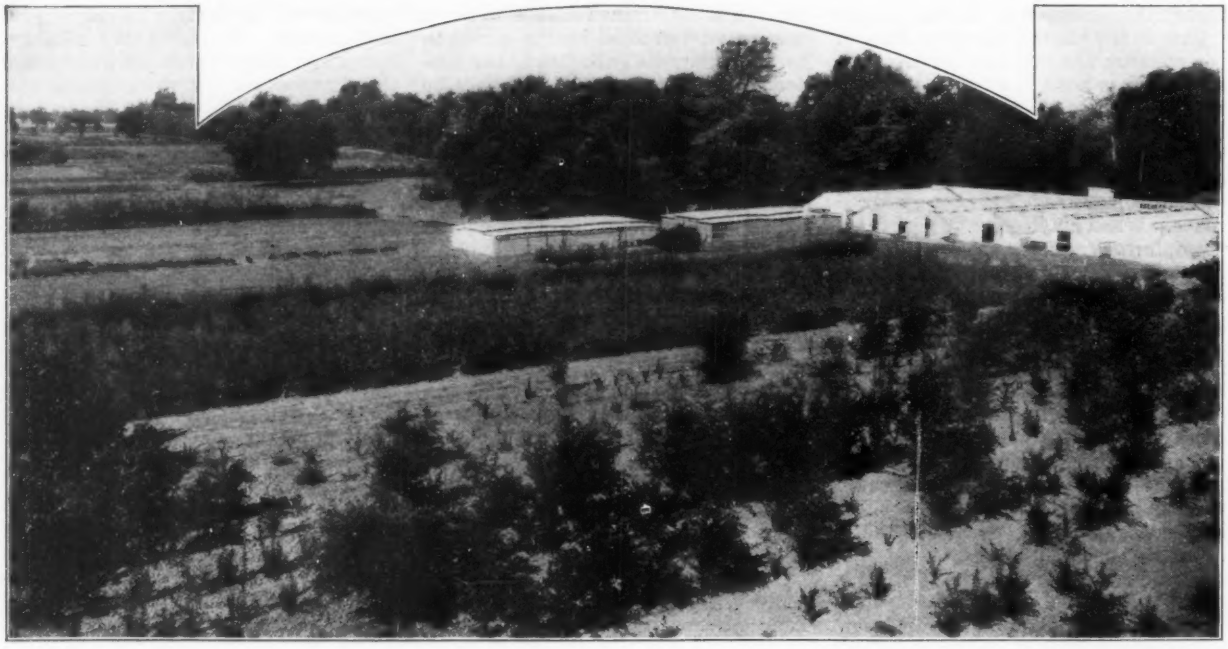
WE have seen that Newtonian mechanics needs modification; that it is a simplification which is permissible only when the wavelength is very small. This of course does not detract from its practical value in every-day life and in astronomy, nor from our estimate of the genius which gave it a form which has satisfied two and a half centuries. On the contrary, the new developments, as far as they concern light, which I have tried to explain to you at such length, are much better expressed in the words of Newton's Optics. "Those that are averse from assenting to any new discoveries but such as they can explain by an hypothesis, may for the present suppose, that as stones by falling upon water put the water into an undulatory motion, and all bodies by percussion excite vibrations in the Air; so the Rays of Light excite vibrations in the refracting Medium or Substance . . . that the vibrations thus excited are propagated in the refracting or reflecting Medium or Substance, much after the manner that vibrations are propagated in the Air for causing Sound, and move faster than the Rays so as to overtake them . . . and that every Ray is successively disposed to be easily reflected or easily transmitted by every vibration which overtakes it. But whether this Hypothesis be true or false I do not here consider."

After being regarded for generations as an artificial attempt to save a dying theory, we have proved this guess of Newton's to be a supreme example of the intuition of genius.



Courtesy Bell Telephone Laboratories

Davisson and Germer also measured the selective intensity of the reflected beam of electrons as a function of speed (potential) of bombardment of target. "We find," says Dr. Davisson, "that it passes through one maximum after another as the speed is increased." (Note curve.) These classic experiments are comprehensible on the hypothesis that electrons are "trains of waves of wavelengths comparable to distances between atoms in solids." All these famous experiments were performed in 1928



Jujube trees are being propagated in the foreground of this scene which shows the greenhouse and nursery at the Chico station

An Immigrant Plant Proving Ground

By Charles W. Geiger

FEW Americans realize that plant introduction has given to the United States practically all of its commercial crops. Thousands of the new plant immigrants that enter the country each year find their first home in the plant introduction field stations, or gardens, of the Department of Agriculture. These are the "Ellis Islands" of the plant immigrants, but they also are the workshops, field laboratories, and plant propagation factories of the Office of Foreign Plant Introduction.

The United States Plant Introduction Garden near Chico, California, is the largest government-owned and operated garden of its kind in the United States. This station serves the State of California primarily, and other regions on the Pacific coast generally. It is located in one of the leading deciduous-fruit, nut, and citrus sections in northern California. The high summer temperature, abundance of water for irrigation, long growing season, and mild winters of this region make possible the propagation and testing of such widely different species of plants as alfalfa from the steppes of Siberia, hardy apples, pears, and cherries from Russia, chestnuts, jujubes, and persimmons from northern China, and citrus fruits from the tropics.

The Chico station consists of 210 acres of land, three hot-houses, and office and residence buildings. The entire garden is under irrigation, the greater part of it under a pressure system. For the entire garden there is an electrical installation of approximately 30 horsepower for pumping service.

CHICO is primarily a propagating and testing station. The plants are tried out there and if they seem promising, they are then distributed for experimental purposes, on order from Washington, to state experiment stations, botanic gardens, arboreta, and similar institutions. There is, in addition, a list of qualified experimenters to whom material is sent when there is more than that required by the regular research institutions.

The thousands of new plant immigrants annually received in Washington in the form of seeds, plants, cuttings, and so forth, from the agricultural explorers and correspondents of the office, are unpacked and given an identification number in the specially equipped plant-inspection laboratory of the office. If a plant immigrant is found to be affected with insects or other pests or with diseases, it is ordered into quarantine, and the necessary treatment is prescribed and administered. If found to be free from insects and diseases, it is given a clean bill of health. It may then be forwarded to the experimenters within the department for whom it was especially secured, or to the plant introduction garden at Chico, California; Coconut Grove, Florida; Bell, Maryland; or Savannah, Georgia. The selection of any particular one of these four gardens depends largely on the character of the plant.

THE plant propagators at these gardens have frequently to resort to every known practice of the craft to save an introduction which arrives out of season or in a critical condition; and in some instances, when the plant introduced is unknown and no information regarding its identity can be secured, they must rely upon their own ingenuity in developing methods of handling such material in order to save what may eventually develop into an important new plant industry.

The propagation houses, cold-frames, lath sheds, greenhouses, and other equipment at the plant introduction gardens of the department, together with trained superintendents, experienced plant propagators, and a corps of capable gardeners and laborers afford excellent facilities for the propagation and preliminary testing of the thousands of new plants annually in-

troduced. They also make possible the efficient distribution of new plant material to specialists of this department, state experiment stations, botanic gardens, and to a limited number of private experimenters.

Among the host of interesting new plant introductions which have been propagated at the Chico station, a few selected examples will give some idea of the range of species handled and the variety of the problems presented.

The jujube, or so-called Chinese date, is a promising plant for California and the semi-arid south and southwest. The experimental tests made with this alkali-resistant and drought-resistant fruit at Chico, to determine the possible value of the strains and varieties that have been introduced, have been very satisfactory. The fruit of the better varieties is fully as large as a large prune, and reddish or mahogany brown in color when ripe. While the jujube is a very good fresh fruit, it is undoubtedly of greatest value when processed with cane sugar or honey. Prepared jujubes are as delicate in flavor as many dates.

From the seed of the tung oil trees (See page 355, May, 1930, SCIENTIFIC AMERICAN) is made an oil which the paint manufacturers of this country consider one of the best drying oils known to the trade. Trees of this plant immigrant distributed from the Chico garden in 1906-07 are doing well and bearing fruit in many places in the region extending from northern California to and throughout the Gulf States, but appear to be doing best in northwestern Florida and the southern parts of Georgia and Alabama.

It has been well said that there is no other plant which is so intimately bound up with the life of man as the bamboo. Here is a forest of it at Chico

The pistache tree, a promising introduction from central western Asia, presages another new industry for the United States. The small, green-fleshed nuts are delicious when roasted and salted, and are extensively used in the coloring and flavoring of ice cream and confections. Almost the entire supply of these nuts at present comes from abroad. The trees do exceedingly well in the Sacramento and San Joaquin Valleys in California. Seedling trees near Fresno, California, have borne large crops of nuts for some years.

Budded and grafted plants of some of the best commercial varieties have been distributed to experimenters interested in testing out this introduction to determine the possibilities for its cultivation as a new plant industry. The peculiar beauty of the Chinese pistache tree and the great age to which it lives have suggested its trial as an avenue tree, and thousands of young trees have been distributed to parks throughout the country. A trial avenue, a quarter of a mile long, planted at the Chico garden in 1910, has already made an excellent appearance.

THE Chinese varieties of persimmon vie with those of Japan in size, quality, beauty, and hardiness. Many varieties have been propagated at Chico and the special Chinese stocks upon which they are grown in China have been used. The region in which the oriental persimmon can be successfully grown commercially includes California and the South, where the temperature does not fall much below freezing. The culture of this excellent fruit is destined, sooner or later, to develop into an important industry. Dried persimmons form a staple food product of China and Japan.

The Chinese dry-land elm is a promising new plant immigrant. This elm is found throughout northern China and Manchuria and is known to be very resistant to drought, neglect, and extremes of heat and cold. Seedling plants of this elm secured at Fengtsi, near Peking, Chihli, China, in 1908, were grown and distributed from the Chico station. These early distributions proved sufficiently promising to justify its propagation in quantity for distribution throughout the United States. The stock at the Chico garden being limited to a few small trees retained for permanent planting, it was necessary to resort to propagation by dormant hardwood cuttings. Tests with this elm indicate that it is likely to be of very great value for

windbreaks, shelter belts, and other plantings in the Great Plains region.

A promising, small, early, sweet cherry introduced from Tanghsi, China, in 1906, was saved to the country by a chance graft. When this introduction was received at the Chico station, the gardener, after working practically all of the scions received upon nursery stock in the usual way, conceived the idea of running the

A section of the nursery at the Chico Plant Introduction Gardens

remainder into the small limbs of an old seedling cherry tree. The scion worked upon commercial stocks all perished, but two of those worked upon the old seedling tree survived. In the following spring these grafts were in full flower before the buds of the seedling tree began to swell, and they ripened their fruit by the time the old tree was in flower, or several days earlier than the earliest commercial cherries of that region. From the scions thus saved, a large number of plants have been propagated and distributed throughout the country for experimental tests. At Yuba City and Vacaville, California, this introduction gives promise of being of considerable commercial importance as an early cherry for the eastern markets.

THE Davidiana peach appears to be quite resistant to alkali and drought and well adapted to the deep alluvial soils of California. It is also succeeding at San Antonio and other places in Texas and has stood a temperature of −40 degrees at the State Agricultural Experiment Station, Ames, Iowa, with little or no injury when 50 other varieties, tested in comparison, were either killed outright or seriously injured.

The fruit of this wild peach is small and inedible, but the introduction may, because of its extreme hardiness, prove valuable in hybridization experiments for the production of much hardier types of commercial peaches.

Interest has been maintained in bamboos and their probable uses in this country for several decades. We have no native bamboos worthy of the name, our nearest approach to the many varied and useful forms of other countries being the arundinarias of the southern states. During the past 30 years the Office of Foreign Plant Introduction has imported into this country more than 60 inventoried numbers of bamboos.

An orchard of the better variety of jujube tree at Chico Gardens

Long before the Department of Agriculture inaugurated its systematic work on agricultural explorations, some 30 years ago, bamboos were being brought into the United States in various ways. These unusual and often strikingly beautiful plants naturally attracted the attention of travelers, who found they could be lifted in clumps and kept alive for several weeks. Isolated plantings were thus early established along the southern seacoasts and some of these have developed splendidly.

EARLY in 1908, David Fairchild, in charge of the plant introduction work of the Department, inaugurated some extensive measures for bamboo introduction. The services of W. D. Hills were obtained in Japan, and he was authorized to get together, grow, and ship to the United States a large collection of three or four varieties of the most important economic bamboos. When Mr. Hills had completed his plans he returned to the United States in the autumn of 1909, on an Army transport, bringing 3500 bamboo clumps with him. The plants were divided into two lots, one being sent to William Tevis, Bakersfield, California, and the other to the Plant Introduction Garden at Chico, California.

The clumps sent to the Tevis place were planted in the open ground in January, when it was cold, and although the best of care was given them, most of the plants died. The Chico shipment was put in a greenhouse and carefully nursed. Heat was supplied and plenty of water given. These plants came through in fair shape, and most of them were shipped to a garden at Brooksville, Florida.

It is impossible to foresee what the future has in store for the bamboo in the United States. That this group is worthy of study and effort is beyond question. Who knows that some day these giant grasses may play an important rôle in our welfare. As our forests disappear and the need is more and more felt for quick-growing and easily worked wood material the bamboo may find an important place here as it has found a vital niche in the scheme of things in many countries of the world.

A Clearing House *for* Inventions

AMONG the many things which have contributed to the development of American business, two infrequently stressed factors stand out significantly. One of these has been the remarkable ingenuity of American inventive genius; the other has been the flair of American business men for commercializing inventions. And yet until quite recently no organized facilities have existed for the promotion of new ideas. American finance, highly organized in all other branches, has left this important field to unorganized or casual direction.

It is common knowledge that the typical free-lance inventor is a lone worker who pursues his own ideas in his own way, often under obscure conditions; and it is rather a strange circumstance that the American inventor today is as much at a loss to know where to turn for the commercialization of his ideas as he was 50 years ago. In the meantime practical and profitable contact between industry and inventors is urgently needed. Every industrial concern today is in danger of having its product or products not only equaled but in some cases bettered or entirely supplanted. Obviously the one effective means of anticipating this serious competition, with its resultant slowing up of production, is to have adequate and systematic access to the wide and growing field of free-lance invention.

EVERY year inventive genius produces thousands of new inventions and numerous new industrial processes. Sometimes they justify the incorporation of separate companies but more often they call for absorption by established industries; that is, if they are properly brought to the attention of those that need them. The inventor, as has been implied, is too often an impractical business man.

Now, however, there is being assembled a group of manufacturers in an organization which will persistently search out new inventions and endeavor to place them in the hands of manufacturers most likely to be interested in their production. This corporation is Campbell, Peterson & Co., Inc., who have had seven years of specialized experience in the examination, selection, and development of new things, and have now evolved a collateral service which provides, on an organized basis, an experienced clearing agency for inventions.

Directed by men of prominence in industry and finance, who are also officers and directors of companies the combined assets of which total over five billion dollars, this corporation is an organized agency to which inventors may submit their ideas for study, classification, utilization, and financing. Fortunately the organization which undertakes this task has already been able to demonstrate in its own experience the practicability of its procedure. Since its inception in 1923 the company has developed through private development syndicates five interesting businesses based on new inventions.

As a clearing house for inventions and the utilization thereof, this organization is setting up an industrial intelligence service which will consist of an investigating and research department and an industrial service department with widespread domestic and foreign affiliations.

THE industrial service bureau will solicit, through advertising and contact, newly invented machines, devices, processes, and so forth, from various sources. It appears conservative that the number of inventions which should thus be made available will range from 10,000 to 20,000 per year, based upon the fact that without advertising or other solicitation the company has received in the past well over 1000 inventions annually. Among the sources which will be canvassed are free-lance inventors, research laboratories of technical institutions, patent attorneys, industrial advisers who have inventions submitted to them, reports of technical societies, et cetera.

In regard to foreign affiliations, the organizers have knowledge of one foreign agency which is now successfully operating and which, it is reported, has access to new inventions of central Europe. This agency, which is headed by prominent European industrialists, has expressed its interest in effecting a working agreement with the American company. Already affiliations have been established for the purpose of attracting new inventions from most of the countries of Europe. It is planned to secure through these foreign affiliations representation in all of the principal industrial cities of the countries concerned.

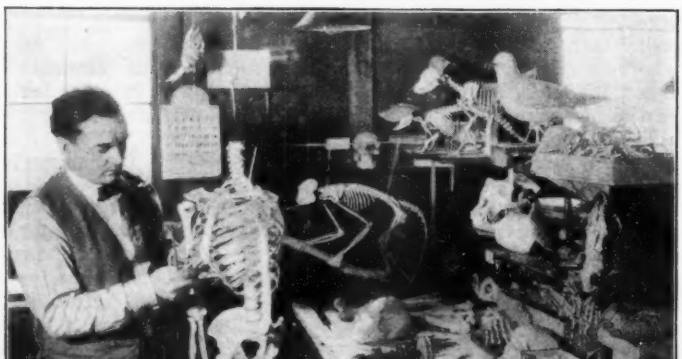
The present investigating department will be expanded so that its facilities will be adequate for investigating all proposals meriting more than preliminary examination. The staff of this department, trained for this purpose and experienced, will assemble and study products and inventions submitted, and satisfy themselves as to their elements of originality and commercial possibilities. It is expected that this department will provide a steady stream of analyses of new and unappropriated inventions suitable for the consideration of American manufacturers.

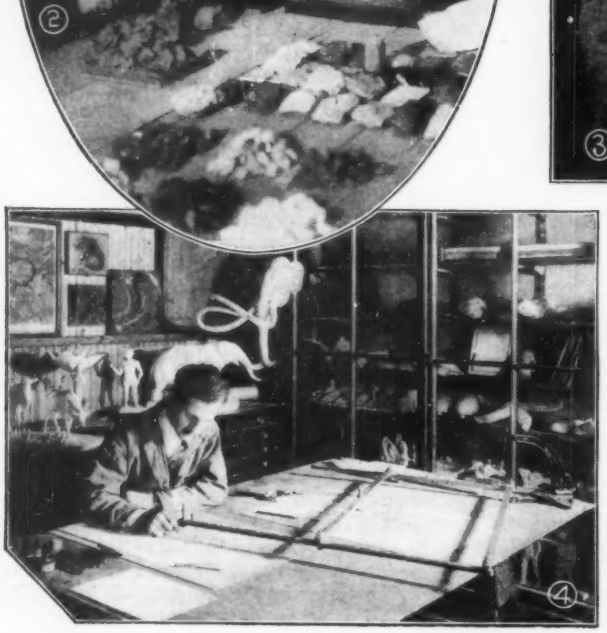
THE information service will be made available to suscribing members in the form of printed bulletins, and drawings or photographs if these are available. Any subscriber desiring further information on any invention may arrange for a further discussion of details. When the matter progresses to a point where purchase or license of a device or patent is contemplated, the subscribing member may either negotiate the matter direct or he may retain the service of the organization. The list of subscribing manufacturers will be limited in number to 200, including one company in each field of industry as those fields have been distinguished in a careful survey. Inventions will be placed outside this selected group when they are not wanted within the group.

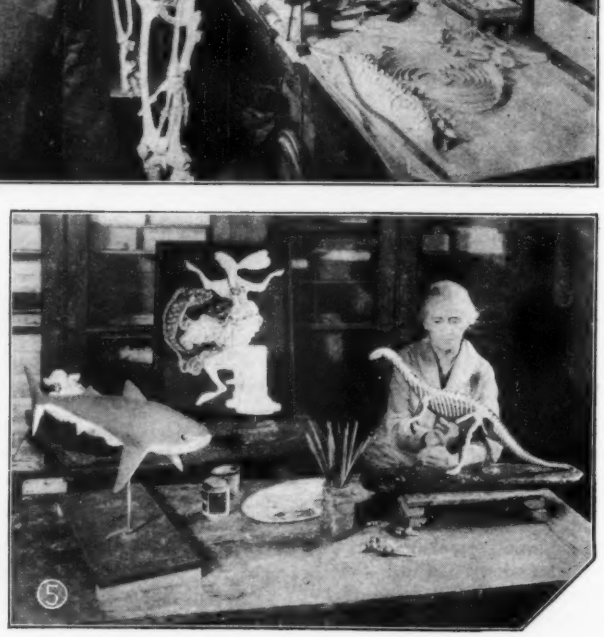
Contact will be maintained with subscribing members not only through the distribution of information in printed form but also by special letters or other communications calling attention to the possible use of certain inventions to meet the particular needs of subscribing members. Regular visits to plants or offices of subscribing members will be made in order to ascertain their needs and increase cooperation. Inventors will be notified of manufacturers' needs and encouraged to co-operate in the solution of their problems.

As occasion arises for the financing of such inventions or processes as are deemed suitable for building into individual industries, the company will form underwriting syndicates.

The inventor who wishes to capitalize his "brain child" but admits a lack of the necessary knowledge of financing problems, who has not the industrial contacts, or who cannot or does not wish to spare the time attempting to sell it to some manufacturer, may thus have all the details attended to by this new well-supported organization. Its liaison service promises a solution to the inventor's problems. With his invention in their hands, the inventor stands a better chance of having it commercialized than if he attempted to do the job himself—and at a nominal cost; and he may then turn his thoughts to other inventions or projects.







ON THE OPPOSITE PAGE

1. Here we see the pioneer staff in the early nineties. These men were osteologists, geologists, zoologists, microscopists, mineralogists, ichthyologists, and anatomists or preparators. Many of them became prominent figures in the educational world. One of them has worked for this institution for 56 years

2. Preparing a rock specimen. The rocks are first broken in the mineral trimmer and then are finished with the hammer

3. Articulating a human skeleton. The osteologist is adjusting the arm so as to permit of the proper movement. Note the picturesque specimens and tools

4. A step in the production of a contour map. Mr. Blackstone is shown enlarging with a pantograph. Relief maps are largely used for educational purposes

5. The artist's corner. Here the expert, Miss Waters, is putting the finishing touches on a scientifically accurate model of an extinct animal, the *Archisaurus*

Mr. Oscar Kirchoff, head of the Department of Biology, is shown examining gorilla skulls which have just been received. The fine collection is unique

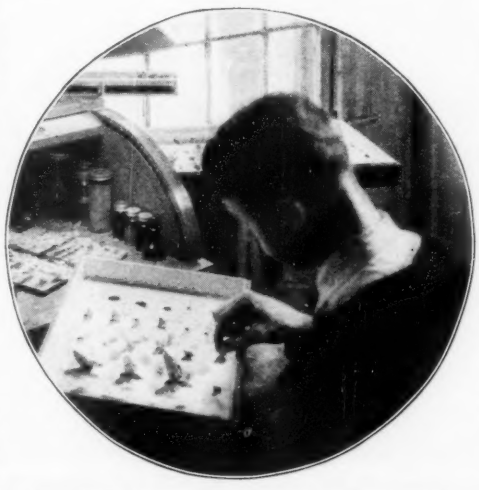
America's Cradle of Natural Science

A Curious Industry Owned by a University to Supply the Needs of Colleges

NESTLING near the University buildings at Rochester, New York, is an interesting group of old buildings where natural science in America may be said to have been cradled. Here was the incubator where many of the leading museum directors and curators of today served their apprenticeship. Among the great names are Carl E. Akeley, Dr. F. A. Lucas, Dr. Wm. T. Hornaday, Prof. James Orton, Dr. Chas. H. Townsend, Dr. Henry E. Crampton, Dr. C. E. Cummings, and a dozen others. The group of buildings are very unpretentious but the interiors are highly picturesque, as will be seen by the illustrations. In the early days taxidermy was in its "upholstery" period. This means that you stuffed an animal the way you would a chair. Akeley changed all this and here is where he learned the art which he was to regenerate.

It might be asked "What is a natural science establishment?" This can be answered best by a quotation from an old circular of the nineties. "This is a serious scientific institution; a great clearing house to which are brought and from which are distributed objects in all departments of nature. These objects we first collect, then prepare, determine, label, and gather into classified series, compiled to suit the needs of museums and educational institutions of all kinds. The general public knows of the establishment as the little village on College Avenue with the whale jaws over the main gateway—where Jumbo was mounted—and where can be seen curios from every clime. To the small boy this is a benevolent institution, where cats, turtles, birds' eggs, snakes and other vermin can be converted into cash. To the naturalist we are a place of terrible temptation, where rare and beautiful specimens of all kinds unite to awaken covetous cravings."

From 1862 this unique establishment, founded by Henry A. Ward, has had no rival. When colleges were indifferent to natural science Mr. Ward held the lamp aloft and kept up interest in the subject. In the period of its existence it has issued 295 circulars and 43 catalogues; the last one (issued only recently) is a valuable reference work of over 200 pages. Among the subjects listed are scientific models, charts, skeletons, zoological material for exhibition and demonstration, entomological specimens and supplies, zoological material for dissection, microscope slides, paleontological specimens, relief maps, geological models, and mineralogical specimens of all kinds.



Mr. Ocorr is transferring to a case specimens of insects which have been expanded

ON January 1, 1928, the ownership of Ward's Natural Science Establishment passed to the University of Rochester, the transfer being made as a gift for a memorial to Mr. Frank A. Ward who for over 50 years directed the affairs of the establishment. In taking over the ownership it is not the intention of the University to conduct the establishment as a money-making institution, but rather to make available all such material as can be supplied at the lowest possible prices.

The writer has visited this institution twice and was reminded very much of Mr. Venus's shop in Dickens' "Our Mutual Friend." Here are boxes of shells, boxes of minerals, boxes of bones, all in great mental order but extremely picturesque to look at. Through the co-operation of Mr. F. H. Ward these pictures were secured.

Aerial view of the jail, the administration building where juries can be locked up, and the criminal court

Copyright by Chicago Aerial Survey Company

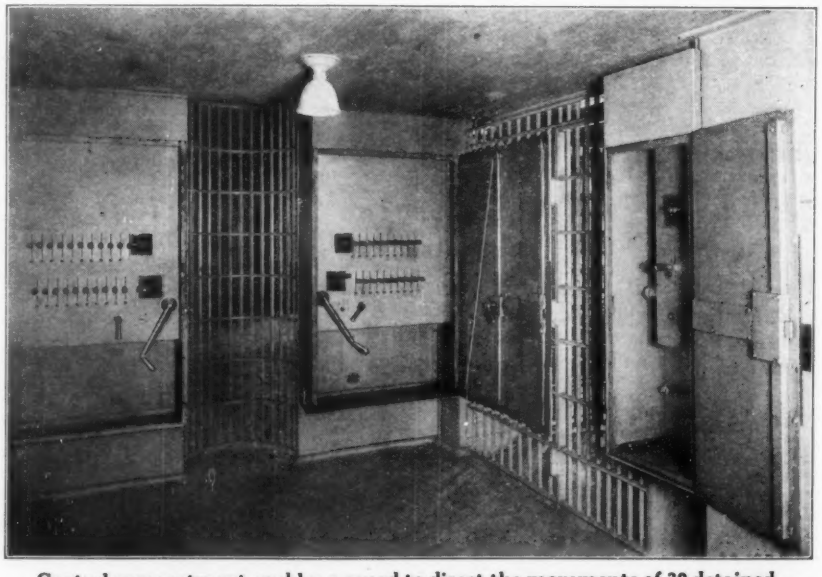
By
Albert A. Hopkins

Chicago Gets a New Jail

CERTAINLY Chicago was entitled to a new jail and when she got one she got a good one, the cost being 7,500,000 dollars. They tried to build for the future but they can put out the "Standing Room Only" sign right now. Of course we know all about Chicago's crime wave but the new jail seems to be about the only answer that can be made to the gangster, the yegg, and the racketeer. The Cook County jail is the largest jail in the United States, and it is one of the most humane ever constructed. The writer is indebted to Mr. Eric C. Hall, County Architect, of the firm of Hall, Lawrence and Ratcliffe, Inc., who designed the structure and to the engineers of the Van Dorn Iron Works for much assistance in the preparation of the present article.

THE site comprises about ten acres and was formerly occupied by a school. It is next to the house of correction, or Bridewell. The group of buildings includes a stately court house, an extremely efficient administration building, and four units of cell buildings. They are all connected by a prisoners' tunnel and prisoners' corridor so that there can be no attempt at rescue. The criminal court building is a beautiful structure 239 feet long, 181 feet wide, and 139 feet high. It contains 14 regular court rooms besides the manifold rooms necessary for the orderly and rapid administration of criminal justice in a large city.

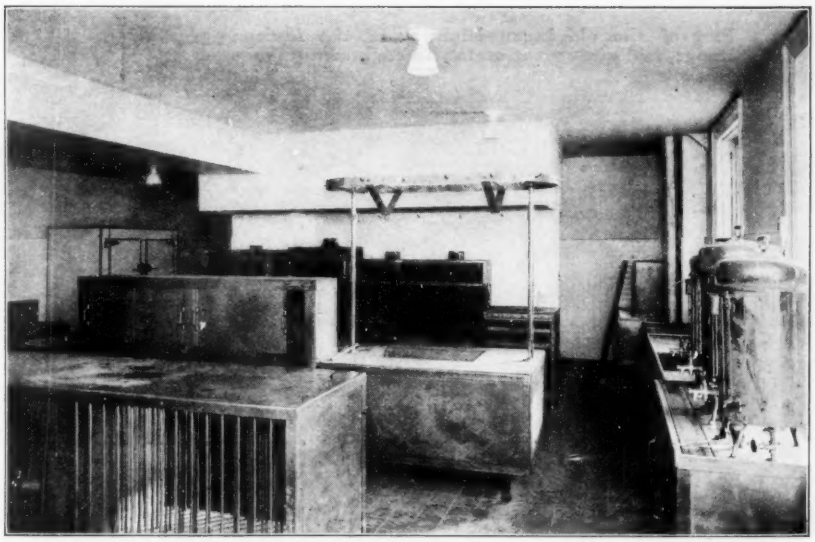
The second building is of considerable interest as it embodies many new features. This administration building also is of considerable size, being 150 feet long and 62 feet wide. It is divided into independent parts between which there is no connection. One is for the accommodation of 12 juries at the same time. Each jury is provided with a three-room suite, two baths, and a separate dining room. There are three rooms in each suite because, although not yet, of the possibility of juries consisting of both sexes. You never can tell when such innovations will take place. There is also a general recreation room for jurors, quarters for jury bailiffs, separate dining rooms, and the jurors' kitchen. The other part of the administration building is for the superin-



Control compartment enables a guard to direct the movements of 39 detained persons. Doors to cells are opened and closed mechanically from this station

tendent of the jail and his assistants and contains facilities for receiving inmates. Looking down from the air a "telegraph pole" is suggested by the disposition of the structure.

The remaining four structures are cell buildings, each consisting of four stories and English basement, 343 feet by 32 feet by 37 feet high. These buildings contain a total of 1302 cells. Additional units can be built as required. The cells are classified as receiving, general, hospital, isolation, and debtors'. They are divided among 36 units. Thirty-two of these are typical, two of them being on each of the four floors of each of the four cell buildings. Each of these typical units is complete in itself, permitting of group classification and segregation of inmates.



In the jurors' kitchen in the administration building hot meals are served to jurors who are locked up to deliberate. Twelve juries can be accommodated

THE typical unit contains 39 cells, each five feet by eight feet by eight feet four inches, made purposely so small that it will not provide for more than one inmate at a time, thereby insuring individual segregation. Each of the cells contains a bed, a bench, a drinking fountain, and a push button, with which to signal the guard in the control compartment.

From the administration building access is given to the four cell blocks at the first floor level, and elevators serve to convey inmates, guards, and visitors to the various floors. At each floor there are two guards' rooms facing each other with the public corridor between. Surrounding each of the blocks of 39 cells and separated from it by a grating is the guards' corridor which enables them to walk completely around the cell area. The windows in the outside wall are located opposite every other cell, thus insuring plenty of light and air.

Adjoining the control department inmates can see and talk through glass which prevents passing contraband

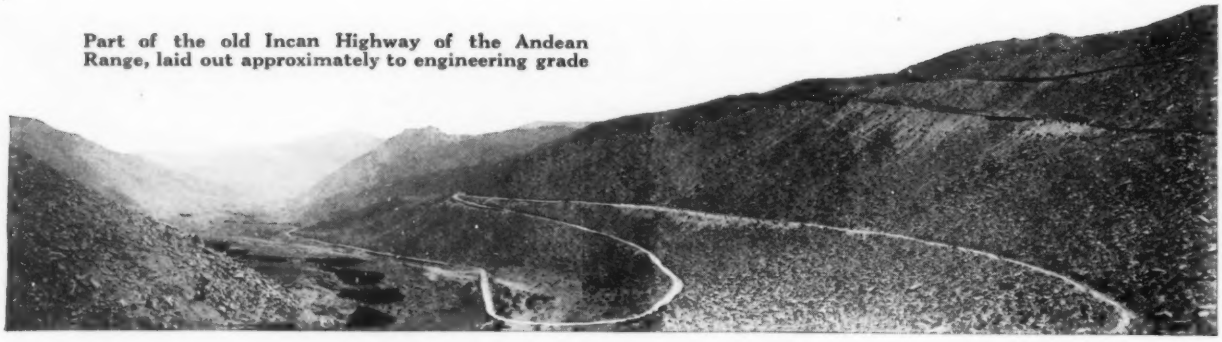
In a cell block 39 cells open into a central cell corridor. One guard controls all doors

The 39 cells open into a central cell corridor and are provided with doors which are unlocked, closed, and locked by means of a mechanically operated locking device. The control is vested in a control box situated in the isolated guards' room. The central corridor on each floor of each cell block leads into the inmates' recreation room, 20 by 31 feet, where the detained persons eat and spend their time when not in their cells. Adjoining is a serving kitchen, the food being supplied by a dumb-waiter from the central kitchen in the basement. In connection with the recreation room, otherwise known as the "day" room, there are toilets and a shower room.

Adjoining the guards' control room is a space where persons who are detained may see and talk with their friends through shatter-proof glass, which enables a conversation to be carried on without danger of smuggling weapons, drugs, or other contraband. Adjoining the guards' control room is a compartment for inmates to consult with their attorneys.

Each cell door is controlled by the guard from his practically armored room. A semi-circular tool-resisting grill enables him to view the entire prisoners' corridor through the recreation room. When a detained prisoner wishes to leave his cell for any legitimate purpose he pushes a button and his call is indicated on an annunciator in the guard's room. The guard then goes to the proper control box (right or left) and by dropping a small lever he unlocks the cell door in question and permits the prisoner to leave his cell. The guard can then lock the door in an open position, if he so desires, so that it cannot be closed without his sanction.

WHEN the prisoner returns to his cell the guard then closes the cell door by means of the large crank shown at each side of the semi-circular grill. The entire operation of opening and closing the door can be accomplished without disturbing any other cell door. All the cell doors in a single row can be opened at one operation at meal time or in an emergency. The steel in the cell blocks is tool-resisting which means that bars cannot be mutilated by the inmates, under prison conditions. The cells are fireproof.



Part of the old Incan Highway of the Andean Range, laid out approximately to engineering grade

America's First International Highway

By A. Hyatt Verrill

Pre-Incan Aborigines Engineered a "Modern" Highway 4000 Miles Through the South American Andes

IN these days of transportation and traffic problems, of the universal automobile, and of the constantly increasing trend of travel to South and Central America, the proposed International Highway is of the greatest interest to the public. But how many of us know that centuries before the first European set foot on American soil an international highway had been constructed and was in daily use?

To be sure, this highway did not link the two continents, but it linked several great nations; it was over 4000 miles in length. Many of the facts regarding it seem incredible, even with our present-day knowledge of road-building and modern engineering, our massive machinery and labor-saving devices.

THE International Highway to which I refer was the "King's Road" of the Incas; a road built by the ancient aborigines of South America; by men who, so far as we know, were entirely ignorant of the use of iron or steel; who possessed no true mathematical instruments, no transits, no compasses, no comprehension of engineering as we understand it. Yet they built their marvelous road through country that presents some of the greatest obstacles. Even the Romans never succeeded in building such a roadway and, compared to the Incan road, the famed Appian Way was scarcely more than a trail.

From Quito in Ecuador, to beyond Tucuman in Chile, the Incan Highway followed the general line of the Andes. At intervals, side roads branched off. A second road 25 feet in width, and almost as remarkable as the first, followed the shore line from Ecuador to Chile.

No one knows when this remarkable road system was started, how much time was required for its construction, what it cost in labor and riches, when it was completed or what man first conceived the idea. Although called the Incan Road, and while unquestionably extended, improved, and maintained by the Incas, yet much of the main highway antedates the Incan Empire by hundreds of years. It is the work of the pre-Incan races. The pre-Incans are shrouded by mystery which no one has yet been able to pierce, and we really know nothing about them, aside from the fact that they were a highly civilized race, were wonderful engineers and builders, and left remains in the form of walls, roads, and buildings that are among the greatest of the world's wonders.

The most outstanding feature of their works are their structures of the so-called "cyclopean type," most of which center in and about Cuzco which, later, became the capital of the Incan Empire. No cement nor mortar was used, the walls and buildings being formed of immense stone blocks, often weighing as much as 20 to 30 tons each, and frequently with many angles—cut, faced, and fitted with such amazing perfection that even today it is quite impossible to insert a knife blade between the stones.

That the same people who erected these titanic structures, by means that have never satisfactorily been explained, built much of the great highway is certain. In many places we find the same type of stone work employed in the road construction, and we know from incontrovertible evidence that much of the material, in the form of giant stone blocks, used in building forts and other edifices near Cuzco,

The old and the new. A motor car and Aimerá Indians, descendants of the ancient, powerful Incans, on the Incan Highway on the Peru-Bolivia border

were transported long distances over the ancient highway.

The road was carried up the stupendous heights of the Andes by accurate, easy grades, by wonderfully calculated hair-pin turns, S-curves and zig-zags. It was carried along the faces of precipices on shelves hewn from the solid rock, or upon masonry abutments built up from far beneath. Ravines and chasms were often filled with solid masonry to form causeways over which the road crossed. Where the canyons were too deep for this the abysses were spanned by suspension bridges supported by immense cables of wool, cotton, or fiber rope. Where the way was barred by insurmountable cliffs tunnels were cut through them.

FOR a great portion of its length, this wonderful King's Road was paved, much of it was surfaced with asphalt or bitumen, and so thoroughly well built was the highway that long stretches of it are still in use at the present time. Throughout the entire 4000 miles and more of the road, there were rest-houses for the benefit of travelers, and which served also as relay stations for the couriers of the Inca. There were "Imperial Inns" every 40 miles. These served as storehouses for food, supplies, and equipment for the army or for the relief of neighboring villages in case of famine or war; and as eating places for the army when on the march.

There was also a continuous series of sentry stations, forts, and watch-towers. A very complete system of signal-fires or lights was maintained, by means of which the men who were constantly on watch could transmit messages from one terminus of the highway to the other. At the time of the uprising of the *Caras* tribe near Quito, Ecuador, news of the revolt was thus received by the Incans at Cuzco, Peru, within four hours after the trouble broke out. To transmit a message from the Chilean terminus of the road to Quito, 4000 miles away, ordinarily required scarcely more than six hours.

Although of great importance for peaceful purposes, yet to the Incans, their highway was primarily a military road. Over it their well-trained, well-equipped armies marched to their innumerable conquests. Over it, according to Incan records, trudged 250 carriers, each bending under a burden of gold, the whole weighing more than ten tons, to be used in making the immense gold chain that Inca Huayna Kapac ordered made to commemorate the birth of his eldest son, Huascar. Over it, too, was transported that marvelous, inconceivable store of gold, amounting to 7000 loads of 75 pounds each, that was sent from Chuquis to ransom the captive Atahaulpa, but which never reached its destination. Somewhere along the ancient Incan road, that vast accumulation of precious metal lies hidden to this day, for when word of Pizarro's treachery and Atahualpa's death was brought to the toiling, gold-laden Indians, they concealed the treasure in some secret spot near Piscobamba.

But the great highway that served the Incans so well in times of peace and war, the international road that connected the far-flung limits of their Empire, proved of inestimable value to their enemies as well. Over the Incan road the mail-clad Dons marched to Cuzco and their wanton destruction of the Incan civilization. And over it, following it across the vast Atacama desert, marched Pedro de Valdivia to his bloody conquest of Chile.

A wonderful, a fascinating, a romantic tale could this old highway tell if it could speak. A tale of riches, of conquests, of murder, bloodshed, and pillage such as the world has seldom seen equaled. If ghosts walk, then, surely, there should be an endless procession of ghosts over this highway.

A bit of the old road where it passes through an Indian village in Peru. Note that it is well paved

BUT even ghosts would find much of it hard going. Long stretches of it have completely disappeared. Many of the bridges have long since rotted and fallen away. Retaining walls have crumbled, letting the road disintegrate. Landslides have bodily destroyed miles of it, and modern roads and railways have cut through it. Still, portions remain in as good condition as ever. Llama trains still plod along it and patter over suspension bridges whose cables were stretched from shore to shore in Incan days. Portions of it also have been improved and incorporated in the splendid system of motor highways being pushed energetically forward. No country in South America has progressed so rapidly in its road work as has Peru. More roads is the watchword, the slogan, of that nation and the system of roads completed is remarkable.

If ever the proposed International Highway reaches South America, we may be sure that Peru will be ready and waiting to do her part of it, if indeed it is not completed through the land of the Incas long before it extends southward to the Peruvian boundary. Unquestionably, much of the great International Highway, where it crosses Peruvian territory, will be laid over the same bed, through the same tunnels made by the forgotten, prehistoric, mysterious pre-Incans. The time may yet come when one may drive a motor car from New York to Lima, or even to Valparaiso.

An Indian village on the old Incan road, in Peru. The hut in the foreground is built on the remains of one of the Incan rest houses mentioned in the text

The Difference Between

The Majority of the Discoveries of Practical the Scientist's Penchant for Prying Into

By F. K. RICHTMYER
Professor of Physics, Cornell University

"TWEEDLE-DEE and Tweedle-dum agreed to have a battle,
For Tweedle-dum said Tweedle-dee had spoiled his nice new rattle."

Louis Carroll, in his famous Alice in Wonderland, has immortalized these celebrated characters and has given a very real meaning to the popular statement that, "the difference between Tweedle-dum and Tweedle-dee is something so trivial as to be entirely unworthy of further notice." When, however, we come to consider the way, if at all, in which this famous phrase is applicable to scientific research, either pure or applied, we realize that the phrase loses much of its popular meaning. Indeed, a glance over the history of physical sciences shows that, so far from being unimportant, "the difference between Tweedle-dum and Tweedle-dee," when carefully observed, has been responsible for a very large number of the striking advances which have taken place in science during the past four or five centuries.

Without discussing this matter in a general way, let us proceed at once to examine certain well known instances in which "the difference between Tweedle-dum and Tweedle-dee" has played an all-important rôle.

WE go back in history to the days of Copernicus, a younger contemporary of Columbus. You will recall that Copernicus, after making a thorough study of the apparent motion of the planets through the heavens, came to the conclusion that the Ptolomaic system of the universe was entirely wrong and that the heliocentric theory proposed by the Greek Aristarchus 15 centuries before was the more nearly correct. According to this latter theory, the planets—Mercury, Venus, Earth, Mars and the others—revolve around the sun in circular orbits. Perhaps the one good reason why Copernicus decided that the orbits were circular was that there was no good reason to suppose them anything else.

Then came the all-important question: What makes the planets move around the sun? The question was not to be answered for many decades, but in the meantime two astronomers made very substantial contributions to the subject. Tycho, the Dane, in the days before telescopes and with only a "sight-tube" containing cross hairs—a telescope without lenses—observed very carefully the positions of the various planets in their apparent motion among the stars. In particular, he made very careful measurements of the planet Mars. A young associate of Tycho was the astronomer Kepler. He was, as we would say today, a theorist and made very careful studies of Tycho's observations on the positions of the planet Mars at various times of the year. He noted that the motion of the planet, as determined from the very careful observations of Tycho, did not quite coincide with the hypothesis of Copernicus that the planets moved in circles. At certain times the planet Mars was not quite in the position which it should be were its orbit circular, the difference being some eight minutes of arc, or roughly one fourth of the apparent angular diameter of the sun. The difference between this predicted position, based on the supposition of a circular orbit, and the observed position was not very much—much less than "the difference between Tweedle-dee and Tweedle-dum." Kepler, however, knew that on the one hand the observations of Tycho could not be in error by even so small an amount as eight minutes of arc and on the other, that his own computations must be correct. *When observation and theory disagree, ever so slightly, theory must be modified.* The orbit of the planet Mars could not be a circle. After much long and tedious computation, Kepler hit upon the happy solution that the orbit of the planet is an ellipse with the sun at one of the foci of the ellipse.

Even so, however, the difference between the two paths, the apparent circular and the actual elliptical, was not very much but it was enough to play a very important rôle in subsequent developments. For, a century later, the fact that the orbits of the planets around the sun are ellipses gave to that great genius Newton, one of the strongest arguments in support of the now famous "inverse square law" of gravitation, a law which every school boy knows by heart and which states, "*Every* particle of matter in the universe attracts every other particle of matter in the universe with a force . . . inversely proportional to the square of the distance between the two particles."

WE who are concerned primarily with physical science, have come to take this law of gravitation for granted. It is an important law applicable in many branches of science—astronomy, physics, chemistry, and so on. But we sometimes forget the even greater philosophical importance of the discovery of this law. Newton saw its terrestrial operation in the falling of the apple. He saw its operation in the solar system in answer to the question: "What keeps the planets in their orbits?" And astronomers came to regard the law as applicable to the most distant stellar universes. For the first time in the history of the world, man came, with the announcement of this law of gravitation, to realize that at least in this one particular there is a common natural law extending and operating throughout the entire universe, a law which governs the motions of terrestrial objects, planets, and stars alike.

Without doubt, we are in large measure indebted for this law to the careful work of Kepler and Tycho in observing *and then interpreting* this small "difference between Tweedle-dee and Tweedle-dum," out of which difference grew the far-reaching law of gravitation as propounded in quantitative form by Newton.

WE pass over something more than a century and come down to about 1825, when many of the best known scientists of Europe were attempting to answer the question which that genius, Michael Faraday, put to himself: Is it possible to "convert magnetism into electricity"? A few years before this, in 1819, Oersted, the Danish scientist, had accidentally found that a magnetic field is produced by an electric current flowing through a wire; or, in the rather loose language of the time, electricity was itself "converted into magnetism."

Numerous observers were attempting the converse: namely, making an electric current by means of a magnetic field. In spite of numerous attempts, by 1830 most scientists had given up the problem as hopeless.

In the summer of 1831, Faraday was working in his laboratory at the Royal Institution of London in one more attempt to solve the problem. He had a hollow helix of many turns of wire, the ends of which were connected to a crude galvanometer; that is, a device for measuring an electric current. Into this helix he was going to introduce a bar magnet, hoping that the presence of the bar magnet would cause a current to flow continuously through the wire of which the helix was made. When, however, he tried the experiment the galvanometer showed no deflection when the magnet was in place.

Tweedle-Dum and Tweedle-Dee

Value to the World Have Been the Result of "Little Things" of Apparent Unimportance

He noted, however, that when the magnet was thrust into place in the helix, there was a very slight, hardly noticeable, motion of his galvanometer; and that when he removed the magnet from the helix there was again a similar slight motion. This slight motion was not what he was seeking and it was exceedingly minute —let us say only 1 percent of "the difference between Tweedle-dee and Tweedle-dum." But Faraday had never heard the couplet at the beginning of this article and to his discerning mind every bit of evidence, however slight, must be taken into account. He, therefore, made a further study of these slight motions.

In an incredibly short time Faraday had shown that these slight motions of his galvanometer indicated unmistakably "the conversion of magnetism into electricity"; and after further study he evolved the physical laws governing the process.

Some four decades later students of applied science began to understand that these laws had a very important practical bearing. An understanding of them led to the development of electric motors and dynamos for the production of electric power. Out of this development in the seventies grew our whole electrical age of today. Within a year or two we shall be celebrating the centenary of Faraday's discovery and perhaps some eulogizer of this great scientist will again point out the very important fact that "The difference between Tweedle-dee and Tweedle-dum" has played a very important part in making this the age of electricity and thereby in revolutionizing present-day civilization.

WHY should Michelson have spent so much time in making new and ever more accurate measurements of the velocity of light? The discovery of argon answers the question.

In 1894 two English scientists, Rayleigh and Ramsay, were interested in making a more precise measurement of the density of the well-known gas nitrogen. Whatever may have been their reasons for making this measurement, we might at the present time look upon their motives as based upon idle curiosity, if you will. When, however, they had determined this density with a higher precision than had ever been attained before, they observed that samples of nitrogen from different sources and prepared under different conditions had slightly different densities. They may have been suspicious of the unimportance of the "difference between Tweedle-dum and Tweedle-dee," and they sought to find the reason for the difference in densities of these samples of nitrogen. The result of this search was most profound. They discovered that the reason for the differences was due to the presence, in varying amounts, of the hitherto unknown gas argon, which, because of its chemical inactivity, had previously escaped detection although it makes up well toward 1 percent of the atmosphere.

Now, one might say that a gas which makes no chemical compounds, can not be seen or smelt, and makes up only 1 percent of the atmosphere is of no great importance. Nevertheless, the discovery of this gas soon led to the discovery of other similar gases and today we recognize a whole series of them, known as the inert gases: helium, neon, argon, krypton, and xenon. These gases are somewhat similar to each other but differ from each other in certain of their physical properties.

Seldom has a discovery been productive of greater results. In recent years we read much about the question of atomic structure; how the atom is like a miniature solar system with a nucleus containing a positive charge of electricity around which are swarming electrons in various states of orbital motion. It is not too much to say that the starting point of the various modern theories of atomic structure is to be found in certain properties possessed by this series of inert gases and it is doubtful whether, had those gases not been discovered, our concept of the atom would be anything like as definite as it is now.

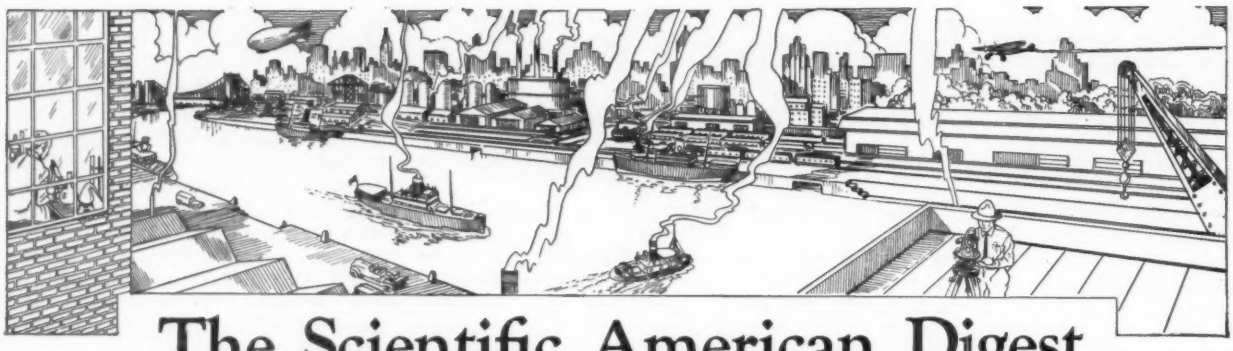
But we need not confine our discussion of the importance of the discovery of argon to matters pertaining to physics and chemistry. We all know that helium is being used as a much safer gas than hydrogen in dirigible balloons; that neon, as well as some of the other gases, is finding important practical uses in electric signs; and that argon has played a very important rôle in the development of the gas-filled incandescent lamp (by its introduction, the efficiency of artificial light sources was almost doubled). Those who are interested, may compute the value in dollars and cents of this particular use of argon and thereby can place a monetary value on "the difference between Tweedle-dee and Tweedle-dum."

But why elaborate the thought further? Everyone will be able to call to mind numerous illustrations of the fact that minute differences such as those which have been mentioned, play a very fundamental rôle in all branches of human activity. Indeed, machines have been taught to recognize "the difference between Tweedle-dum and Tweedle-dee." For example, one of the important revolutions in modern machinery has been the introduction of the ball bearing and the roller bearing. The very success of the ball bearing depends upon making steel spheres which differ from each other in diameter by not more than one ten-thousandth of an inch. Two Fords—at least as they leave the factory—are much more nearly alike than the proverbial "two peas." The ability thus to duplicate parts is one of the striking successes of our modern industrial life.

ONE catch-phrase definition of a genius states that, "a genius is one who has an infinite capacity for taking pains." Like many another of its kind, this definition contains just enough of truth to make it somewhat dangerous. Many a man has an infinite capacity for taking pains, but he will never be a genius.

I propose an alternative definition: A genius is a man who can observe *and interpret* "the difference between Tweedle-dee and Tweedle-dum." And let us emphasize "interpret." It was not so much Kepler's discovery of the slight discrepancy between theory and observation in the motion of Mars; it was his ability to interpret this difference that brought him fame. It is quite probable that other investigators before Faraday had observed similar "kicks" in galvanometers, but Faraday regarded the minute disturbances as worthy of further study. Had Ramsay and Rayleigh been content merely to point out that different samples of nitrogen seemed to have different density, we might have waited a long time for the discovery of the noble gases, with their important uses in both science and industry.

A very large part of present-day research in science depends on devising instruments and methods for making more and more accurate measurements, for observing minute differences hitherto beyond detection. So frequently has it happened that new phenomena have been discovered when such measurements have become possible, that it is now almost an axiom that "a new discovery is to be found in the next decimal place." Michelson's motive in repeating, each time more precisely, his determination of the velocity of light thus is obvious.



The Scientific American Digest

Conducted by F. D. McHugh

Direct-Reading Light Intensity Meter

ONE of the latest uses of the photoelectric cell is in connection with a meter to measure light intensity, now being built at Newark by the Westinghouse Electric and Manufacturing Company.

This cell, in various special constructions, has already found many uses in industry and is finding new ones almost

The photoelectric cell is an important part of this light meter

continually. The present meter, embodying a new application of the photoelectric cell, should render unnecessary the question in a picture studio, "Is it light enough in here?" A photographer need not wonder whether the north light today is as strong as it was yesterday, for the meter always gives the same values for the same intensities. Used in connection with a printing frame it makes possible accurate adjustment of lights when certain special printing is to be done.

The instrument is complete in a case 12 1/2 by 10 by 6 5/16 inches, and consists of a special cell of broad response covering the visible spectrum, in series with the smallest size "B" battery and a microammeter calibrated directly in foot-candles. The light "pickup" or cell, something like a radio tube in appearance, is connected to the meter by a cord and may be moved about a six-foot radius outside the case. Normally directional, so that light from given points may be studied, it may be made non-directional as well.

The sensitivity of the meter is pronounced; used in tests at a motion picture studio, it showed the change in illumination of an actor's face when he lighted a cigarette.

Further suggestion of its value is seen in the studio where Mazda lamps are used with panchromatic film, in color photography where intensity of special colors is desirable, and in cinema houses to measure the screen illumination. It may also be used to determine illumination in factories.

The New Digest

WITH the express purpose of improving the quality—as to selection, preparation, and appearance—of the material heretofore presented in SCIENTIFIC AMERICAN following the major articles, we inaugurate this month what might aptly be called a *super* SCIENTIFIC AMERICAN Digest. This enlarged section of the magazine will contain items formerly segregated and published under various specific heads, but their authorship will remain as before.

Professor Alexander Klemin, in charge of the Daniel Guggenheim School of Aeronautics and Associate Editor of SCIENTIFIC AMERICAN; A. E. Buchanan, Jr., Lehigh University, Corresponding Editor of SCIENTIFIC AMERICAN; and Morris Fishbein, M. D., Editor of the *Journal of the American Medical Association* and of *Hygeia*, and Corresponding Editor of SCIENTIFIC AMERICAN, will be responsible for the articles, signed by their initials, in their respective fields of aviation, chemistry, and medical science.

Fireproof Houses in France

DWELLINGS of fireproof wood are being erected in France by a German concern as part of the reparation payment. Each month 100 five-room houses of this type are being erected at a fixed price of 1500 dollars each.—*Engineering News-Record.*

Arrow Point Injuries

ALTHOUGH the stone arrow-points used by prehistoric Indians are fairly common, yet it is rarely that they are found imbedded in human skulls or other bones. Collectors of Indian relics regard such a find as is pictured on this page as a great prize. Numerous instances of such finds are known among the Indians of the eastern and middle North America, but the one shown here is the first to be recorded from the southwest. It was found on San Nicolas Island, one of the channel islands off the coast of California. The skull was associated with another cranium containing a small, black obsidian point. The present case shows the point firmly fixed in the right temple where its situation shows that a large artery inside the head was cut, and the Indian died of cerebral hemorrhage.

Angleworm Big as Snake

IF you happen to be in the Philippine mountains some day, and see an angleworm as big as a small snake, colored bright blue with pale yellow spots and bandings, don't blame it on something you may have eaten (or drunk) in the last village. It's real, and it's there, although it is a zoological rarity. Dr. M. Michaelsen, of Hamburg, Germany, has just reported to the *Philippine Journal of Science* on specimens collected in Luzon some time ago and forwarded to him by a fellow-countryman, W. Schultze, formerly an entomologist at the Bureau of Science in Manila. The specimens, when living, were over a foot in length and nearly an inch in

A relatively rare find: An Indian skull retaining the arrow head which killed the Indian ages ago

greatest diameter. They are of a species new to science and have been named *Pheretima ophioides.—Science Service.*

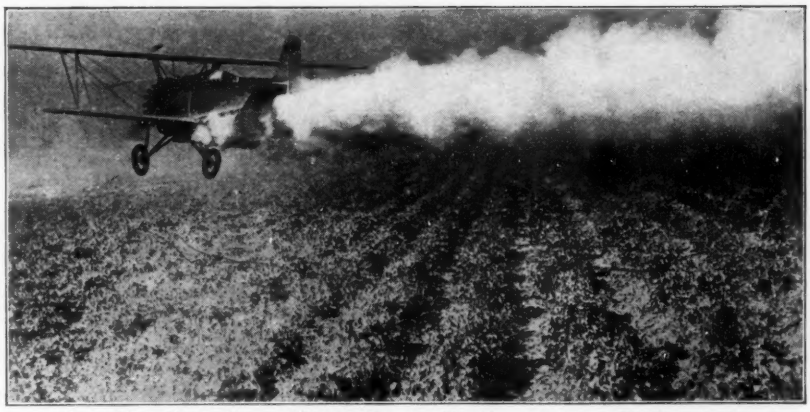
Chemical Warfare Turns to Peaceful Victories

WHILE the chief duty of the United States Chemical Warfare Service is military, it has made numerous contributions to chemical science and industry in peace time. The widespread activities and accomplishments of this branch of the service are described by Lt. Robert E. Sadtler in a recent issue of *Chemical and Metallurgical Engineering.*

"Among the more important of these," says Lt. Sadtler, "is the development of compounds that will destroy the boll weevil more effectively than the calcium arsenate generally used; it (the Chemical Warfare Service) has demonstrated the use of tear gas in controlling mobs; it has developed gas masks for protection against industrial poisoning and ammonia fumes, and for the use of the public health service in its work of fumigating buildings. It also has assisted the shipping industry by three commercially valuable developments: toxic ship-bottom paints, protection of marine piling, and a safer and more effective method of ship fumigation."

"Anti-fouling paint, according to the estimate of competent authorities, will save the shipping industry from 125,000,000 to 150,000,000 dollars annually in reduced fuel and maintenance costs. The need of a poisonous paint for the exterior of hulls of ocean-going vessels is due to the accumulation of marine organisms, which increases fuel consumption and reduces the ship's working time by the amount spent in dry dock to clean the bottom. Barnacles are the principal marine organism attaching themselves to the ship's bottom. Not only commercial but naval vessels are affected by this growth."

Another interesting discovery made by the Chemical Warfare Service is that of the use of tear gas in controlling crowds and individuals. The effectiveness of this method in comparison with the old one of subduing the mob by the free use of bullets has been demonstrated frequently. A simple tear gas, chloracetophenone, in harmless, non-explosive tear-gas grenades, may be used effectually without permanently injuring anyone who may encounter



Attacking the boll weevil from the air. Dusting cotton with chemicals

it. This tear gas is a non-poison in the concentrations obtainable in the open air, and yet is effective even with one part of tear gas to three million parts of air. Its only reaction is to cause smarting of the eyes and the stimulation of the lachrymal gland causing a copious flow of tears.

Still another service which the Chemical Warfare Service has rendered to peace-

Two views of the new locking terminal for engine spark plug cables

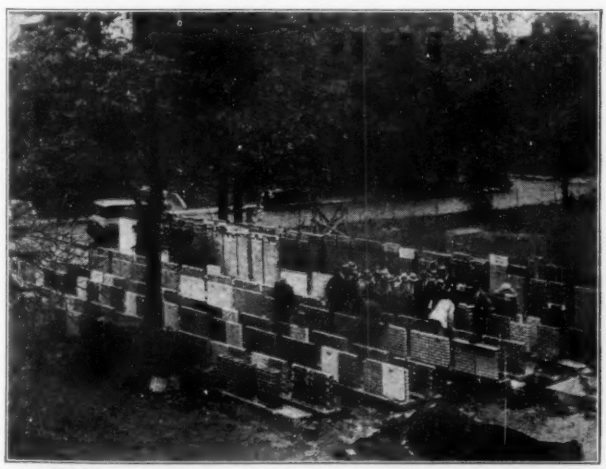
time America is the development of various kinds of gas masks as protection against the deadly gases employed in many industries, and the detailed study of methods to prevent the fatalities resulting from other forms of poison. Since all of these poisons have at one time or another been brought to the attention of the Service as possible chemical warfare agents, the Service has necessarily made a close study of them and of methods of protection against them, and has been able to offer freely to industry the knowledge thus gained.—*A.E.B.*

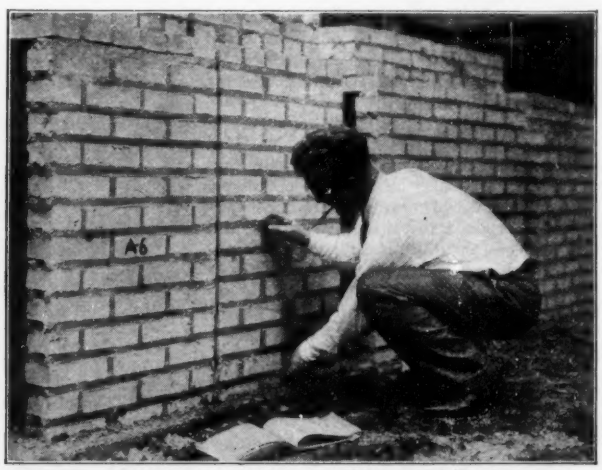
A Locking Cable Terminal

THE accompanying photograph shows an interesting locking spark-plug cable terminal which has been approved by the Army Air Corps for airplane use. Powerful phosphor bronze jaws of this new terminal make firm contact with the spark plug. Then the contact is locked by a hinged bale that swings down across the end of the terminal. Violent air maneuvers, rough landings, sudden propeller blasts, engine vibration, or bumpy roads cannot loosen its firm grip. Yet, in service, the terminal may be removed as quickly as the ordinary kind.—*A. K.*

Scientific Research on Bricklaying

AN interesting example of collaboration between scientist and artisan is found in the broad scientific study of bricklaying recently inaugurated by Mellon Institute of Industrial Research and the Eastern Face Brick Manufacturers' Association. The experiments are being carried out by Dr. F. O. Anderegg, Senior Industrial Fellow of the Institute's Multiple Industrial Fellowship on Portland Cement, and his assistants; architects, building contractors, and masons are aiding the work





Above is shown the group of experimental brick walls that has been built on the grounds of the Mellon Institute. *At right*, an assistant makes use of the strain gage, sensitive to 0.002 inch, for measuring shrinkage

Friendly enemies exchanging reminiscences. Major George A. Vaughan, Jr., second American ace now actively engaged in the aircraft industry, and Captain Franz Carl Schlieff, former war pilot of the German air force. Major Vaughan was credited with 13 enemy planes during the war while Captain Schlieff accounted for 22 before the British shot him down on the Somme. Here he lost his left hand in the crash

by contributing opinions and advice based upon experience.

So many varying factors are involved in the construction of a brick wall that it has been necessary to limit the experimental study to combinations of variables representing the probable range of practical application. Hundreds of thousands of experiments would be required if all possible combinations were to be studied. For this reason the research program has been under discussion for a considerable period of time, and the actual investigation was begun only when a satisfactory plan had been elaborated. Up to the present time some several hundred experimental walls or panels have been erected.

In brief, the investigation will cover certain aspects of all the factors involved in bricklaying. The most obvious points of attack are studies of the characteristics of different kinds of brick and mortar. Problems of special appeal to the practical man are those concerned with different methods of backing and with differences in workmanship. The design of walls and their relative elasticity are subjects which will be of considerable interest to contractors and architects.

Brick and mortar problems under investigation include the absorption and surface characteristics of brick, and differences in mortars due to varying the cementing materials, sand, and pigments. Properties of the mortars which are being studied carefully are workability, compressive and transverse strength, absorption and permeability, shrinkage, durability, staining and efflorescence, and elasticity. Information is being collected to determine whether the 10 percent of lime often specified by architects or the 25 percent or more usually employed by brick masons gives better all-around results.

The problems in backing include a study of hollow tile of different sizes, of brick, of cinder or concrete block, of brick tile, and of metal or other lath on steel frame. Variations in workmanship are most apparent in regard to tapping, pointing, and the filling of head-joints. The first mentioned subject is being studied, not only in regard to the effect of excessive downward tapping into place, but also in regard to plumbing both before and after initial set.

Nested Rigid Chairs Easily Stored

SINCE the time of the Pharaohs of ancient Egypt, there has been but little, if any, improvement in folding chairs. The same scissors-like legs that were used on chairs found in tombs of the Pharaohs are still used in making chairs that are collapsible for storing purposes, for ease in moving them in numbers, and so forth. And they are still as roundly sworn at for pinching fingers and tearing clothes as we assume they were in those olden days.

Two chairs of the type recently invented. They telescope one into the other for storage purposes

A patent has recently been granted, however, to Mr. Louis Dellert, of Brooklyn, New York, on a chair of conventional appearance but of novel design and construction. These chairs are made of sturdy pressed metal, and although they are rigid and non-collapsible, they effectively serve the purpose of folding chairs since they telescope one into the other.

All chairs of a set made according to this design are identical in all respects. Telescoping is possible because the seat frame is open in the rear and the sides of the seat frame, which is formed of metal, converge toward the front legs while the rear legs are securely mounted at the rear of the seat frame on the outer side. The thin metal seat slopes slightly forward. Any number of the chairs may, therefore, be nested, each additional one occupying only two or three inches more space.

They may be made in any period style, may have arms if desirable, and their seats and backs may be upholstered by means of thin removable cushions which may be stored between the backs when chairs are nested. A chair of this new type is well adapted for use in homes, banquet halls, or other places requiring strong, durable, attractive chairs that can be easily stored when not in use.

Tractor Efficiency on the Farm

AS the horse is gradually supplanted by the tractor, the American farmer evidences a rapidly developing native ingenuity in the use of this modern time-saving aid to greater efficiency and profits.

On this page we show a tractor of the articulated tread type, equipped with five planters for fertilizing and planting four rows of corn and one row of peanuts. The planters are attached to the beam with a flexible hitch that allows a free up-and-down movement but prevents side movement. Three-inch spacing on the beams allows for any desired variation in the row width.

Chemical Prevents "Fatigue" of Rubber

EVERYONE knows that a piece of rubber can be stretched to several times its original length and will return almost completely to its original form as soon as the force is released. However, when rubber is stretched, released, and stretched again hundreds of thousands of times, it undergoes a form of deterioration which, for lack of a better name, we call "fatigue." When ordinary rubber "gets tired" it cracks; witness, for example, the cracks that develop on a pair of rubber boots where they are folded.

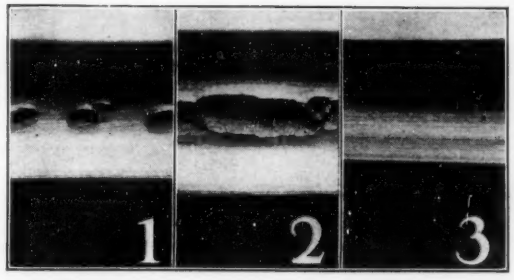
Rubber chemists of E. I. DuPont de

The ever-useful tractor leads to greater farm efficiency

Nemours Company have discovered that a very small amount of certain organic chemicals, introduced into the rubber before vulcanization, prevent "that tired feeling" and the resultant cracks in the rubber. The remarkable action of these chemicals, marketed under the name "Neozone" is described by E. R. Bridgewater in a recent issue of the *DuPont Magazine*. Referring to the use of Neozone in tires, he says:

"Carbon black made from natural gas is used by practically all tire manufacturers to toughen the tread rubber, thereby making it more resistant to abrasion. Most manufacturers use approximately two parts of carbon black to five parts of crude rubber, in high-grade tire treads. Greater amounts would be used if it were not for the fact that when more of this black pigment is used, there is a tendency for the rubber to crack at the points where it undergoes the most severe flexing when the car is in motion. It has been found that when small amounts of Neozone are added to the tread formula, considerably greater quantities of carbon black can be used without causing the rubber to crack at the points of flexing."

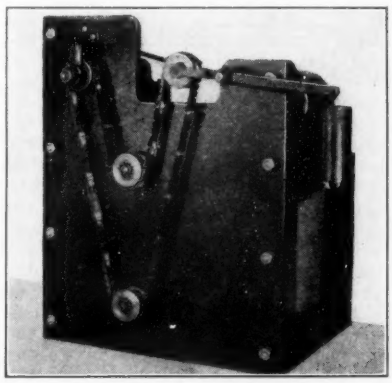
Many other rubber products, such as parts for hydraulic brakes, rubber belts for transmitting power, rubber wire-insulation, and many rubber articles whose purpose is to absorb shocks and vibration, have been improved in this manner.—*A. E. B.*



No Neozone is in sample No. 1 which shows the effect of bending a piece of rubber around a small pulley 1,500,000 times. Number 2 is identical and has gone through the same tests. Number 3 is identical except that it contains 1 percent of Neozone. It has undergone the test 3,750,000 times without cracking

A Compass Turn-Table

SERIOUS errors in the aircraft compass often occur owing to the magnetic fields of the airplane's steel parts. The process of compensation is termed swinging the compass. For "swinging the compass," Army flying fields are equipped with circular concrete platforms. The platforms are placed not less than 100 yards from any steel structure, such as a hangar. Starting with the magnetic north, radii are laid out every 30 degrees. A dolly is used to elevate the tail so that the airplane is in approximately flying position with the engine running. The airplane is headed to various points of the true compass and deviations are noted and corrected by special compensating magnets, until the errors are reduced to a minimum. A table of corrections is then compiled. A useful wrinkle for expediting this process has been devised at the Croydon Airport in London. A special turn-table is provided on which the airplane is placed. It can then be swung to various directions in a fraction of the time required when the airplane is slowly turned by man power. The turn-table is easily turned by one man.—*A. K.*



The flexing machine developed by the DuPont laboratories for fatiguing rubber. The weight at the right regulates the tension on the V-shaped sample "belt" of rubber

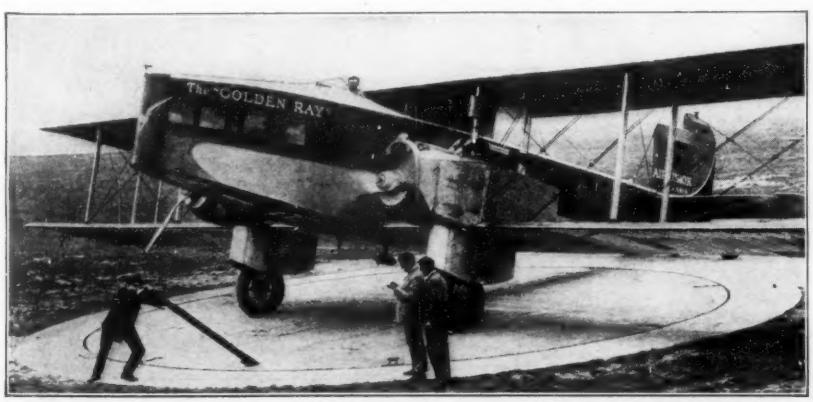
X rays and the Tonsils

THERE are various methods of controlling enlarged tonsils—they may be removed by surgery; they may be destroyed by heat through an electric cautery or through electric heat; or they may be X rayed. As far back as 1913 it was suggested that X rays be used for the control of enlarged and infected tonsils, and since that time numerous papers have been written as to the effects of X rays on these tissues.

In the last quarter century hundreds of thousands of people have had their tonsils removed and it is now generally understood that removal of the tonsils is advisable in the presence of infection or of extreme enlargement. However, there is also considerable conservatism concerning the removal of apparently normal tonsils.

In St. Luke's Hospital, New York, Dr. Leila Charlton Knox has given special attention to the possibility of treating tonsils with X rays. She does not advise the use of X rays in children, particularly those with rheumatic symptoms. She does feel, however, that X rays provide a useful method in all cases in which operation is not advisable because of some secondary complication, particularly heart disease. Neither do X rays seem to be indicated in cases in which there is acute infection or a complicating disease such as diphtheria or scarlet fever.

X rays seem to be useful in the control of the secondary growth of lymphoid tissue in the form of stumps after the tonsils have been removed surgically. The method is also useful in elderly people who are troubled with chronic or repeated sore throats.—*M. F.*



At the Croydon Airport, a turn-table for "swinging the compass"

Man Linked With Ground Sloth

WHILE the part of this magazine containing the article "The Mystery of Gypsum Cave," by Dr. M. R. Harrington of the Southwest Museum (page 34) was in press, the following telegram was received:

"Have found what seems to be the campfire of our sloth hunters: a patch of real charcoal under a layer of unbroken sloth dung capped by more than seven feet of undisturbed strata in the topmost of which are found Basketmaker and early Pueblo artifacts. This find to my mind establishes beyond question the association of man and the sloth.—M. R. Harrington."

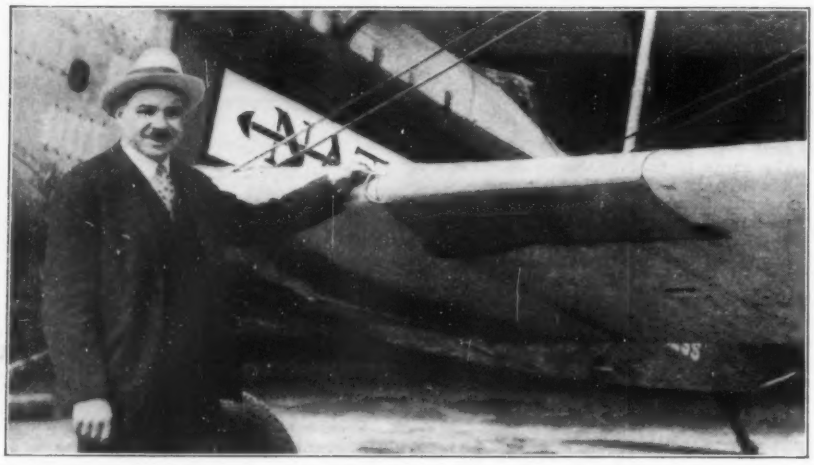
Dr. Harrington's beliefs, as expressed in his article, apparently have been vindicated.

Carbon Remover

IT is a well-known fact that if a gasoline engine of the poppet valve type can be kept relatively free of carbon, the intervals between necessary removals of the cylinder head can be increased greatly. In the article "Your 1930 Car," published in our January 1930 issue, we mentioned a product of the Alemite Corporation, called Carbosolve, which has been installed as standard equipment on Chrysler cars.

This carbon removal system is now available for use on all cars, having recently appeared on the market in "kit" form. Essentially, it involves the use of a valve permanently mounted on the dash, and with a connection to the center of the intake manifold. The valve is so arranged that a can of the special carbon-removing liquid can be attached when it is desired to treat the explosion chambers. The makers recommend that this be done every 500 miles.

When the device is to be used, a can of



Leslie L. Smith of the N. A. T., exhibiting the airplane "overshoe"

the liquid is attached to the valve, the motor is warmed up to running temperature, and the valve knob is pulled out and the motor shut off simultaneously. The liquid is sucked out of the can and is equally distributed to the cylinders. The engine is then allowed to stand undisturbed for at least three hours, or overnight. It is then started and the carbon, loosened by the action of the liquid, is blown out with the exhaust.

Airplane Overshoes

DR. WILLIAM C. GEER'S "airplane overshoes," developed with the aid of a subvention from the Daniel Guggenheim Fund for the Promotion of Aeronautics and with the co-operation of N.A.T. and the B. F. Goodrich Company, give promise of conquering one of the most serious hazards of flying.

The adhesion of ice to metal—polished aluminum for example—is high. The adhesion of ice to other substances varies greatly, and to some it is remarkably low. In previous attempts to solve the problem, the surface of the airplane wing has been covered with oil. The oils used have generally become viscous and sticky at their freezing temperatures, and moreover the wind forces have scrubbed off the layers of oil.

Profiting by these early mistakes, Dr. Geer selected a group of oils the freezing points of which fall below 20 degrees Fahrenheit, and the boiling points of which are high. Such oils would possess mobility at ice-forming temperatures and would be non-drying over long periods of time.

The second difficulty was to prevent the scrubbing off of the oil by the wind. To render this scrubbing off impossible, the oils were absorbed into thin sheets of vulcanized rubber, which can absorb a large volume of oil. To avoid the weakening and deteriorating effects of oil upon rubber, the effects of over 100 oils and oil mixtures were investigated. Finally an oil mixture was found which gave to the vulcanized rubber practically zero adhesion to ice and which left its physical properties unaltered. Moreover, the rubber thus treated showed the property of exuding oil at the freezing temperature. During the course of the intensive research work conducted in connection with this problem, it was found that the volume of ice formed on an untreated rubber sheet is somewhat less than upon other substances.

There then remained the problem of removing ice should this be formed despite the oil impregnation. Ice formed even upon a zero adhesion surface does not remove itself. It shapes itself perfectly to the wing and at the leading edge the low pressure over the wing helps to keep it on. To meet this third difficulty, Dr. Geer invented a simple mechanical device. This took the form of a light-weight thin rubber "overshoe," or pneumatic nose, for the leading edge, with a fabric backing for strength. In the leading edge of this overshoe was placed an air tube strengthened with extensible fabric. This inner tube was connected to a pump, either motor or hand driven. The tube lay flat when collapsed and so altered the curvature of the wing very little. If ice forms in spite of the impregnated rubber, the pilot turns the air into the tube, thus slightly expanding it. This moves the ice and breaks the vacuum. The only precaution to be observed when flying under ice-forming condition is that the pilot should "break the ice" when the layer is still thin. These overshoes are designed to be applied only when bad weather is expected, just like the overshoes of our everyday life.

In a test run in Cleveland in March, an overshoe was attached to a radio mast behind the cockpit. During the flight, ice formed to a thickness of about one half inch over the leading edge. A hand pump was used to expand the tube. When a pressure of two pounds per square inch was applied, the ice suddenly left the overshoes, flying off in chunks. Experiments on a wing and on a strut were similarly successful.

These experiments made in full flight are very encouraging. While pilots and operators always object to the addition of "gadgets" to aircraft, this gadget at least seems well worth while and we shall await further developments with keen interest.—*A. K.*

Measure the Speed of Dynamite Explosion

ONE of the most rapid chemical reactions known takes place when a stick of dynamite is detonated. It has been found that the detonation wave travels along a cartridge of dynamite at speeds as high as four miles a second. These speeds were measured at the Explosives Experiment Station of the U. S. Bureau of Mines, Bruceton, Pennsylvania, in connection with research and testing of mining explosives.

In one type of apparatus, known as the Nettegang recorder, the time elapsing between the breaking of two wires threaded through the explosive is recorded on a rapidly revolving smoked drum. In a method recently developed, the explosive is placed behind a narrow slot cut in a sheet of armor plate and the detonation process is photographed by its own light on a rapidly moving film. This method has the advantage that it records the speed of the detonation wave at every point along the column of explosive. It has been found that the speed of gelatin dynamites is affected by the degree of confinement under which the charge is fired. A charge of gelatin dynamite confined in a steel tube may detonate at a speed several thousand meters per second faster than a similar charge detonated in the open.

The explosion of a charge of dynamite is usually associated in our minds with a deafening concussion, but this is true only of dynamite fired in the open air. Charges of dynamite are exploded in massive steel bombs at the Pittsburgh Experiment Station of the Bureau of Mines, with only

Gelatin cartridge house, Mineral Springs plant of the DuPont company, showing earth barricades which serve as protection in case of explosions

a metallic "click" to indicate that the charge has exploded and that pressures of 10,000 to 20,000 pounds per square inch have been produced inside the bomb. These bombs, known as Bichel gages, are used to measure the actual pressures produced by detonating explosives when fired in a borehole. The magnitude of the pressure is a measure of the ability of the explosive to do work.—*A. E. B.*

Trees Must Have Water

TREES need enormous quantities of water to keep them in a healthy condition, says the United States Department of Agriculture. An apple tree 30 years old gives off approximately a barrel of water a day in summer, and a good-sized birch tree gives off nearly two barrels of water on a hot day. A single oak tree is known to have given off into the air in the form of vapor more than 100 tons of water in a single growing season.

Chromium Poisoning

CHROMIUM is one of the chemical elements most commonly used in many industries. In etching zinc and aluminum plates in lithography, a mixture consisting of gum arabic, chromic acid and phosphoric acid, is applied to the plate with a brush or sponge and almost invariably comes in contact with the hands of the user. In another lithographing process, chromic acid or ammonium bichromate may be applied in other ways.

Drs. Carey P. McCord, Hobart G. Higgenbotham, and J. C. McGuire made a study of the hands of 37 workers, of whom 25 were lithographers and 12 were tanners. The application of the chromium mixture to the unbroken skin resulted in inflammation of the skin in 20 out of 25 cases among lithographers and in 10 out of 12 cases among tanners. The reactions included the inflammation of the skin and in some cases blisters.

It has for some time been realized that chromic acid or chromium compounds could bring about severe conditions when coming into contact with the broken skin, but it has been believed that chromic compounds would not attack the unbroken skin. Recent experiments indicate quite certainly that this belief is not supported by scientific evidence.

In studying eruptions of the skin it is important to keep in mind the occupation of the worker. Numerous irritants are employed in household work and in various trades. A condition called "photographer's eczema" is due to some of the chemicals used in developing pictures. Electrotypers and stereotypers and foundrymen get eruptions from the substances with which they work. Bleaching preparations of all sorts, hydrochloric acid and bichromate solutions used in the tanning trade, aniline dyes, shellac, and various plant extracts may cause irritations of the skin which must be studied carefully in order to be sure that the eruption comes from an irritant applied on the outside rather than from something in the blood developed inside the body.—*M. F.*

Dictaphone-radio hookup used in Oregon for recording market reports. As the prices are broadcast, they are" caught" on the machine's wax records

Spot-News via Telephone-Dictaphone

FROM the king's palace to the newspaper office may be a thousand miles, but the city editor of 1929 can look in on the coronation and be back at his desk in a few minutes. He can flash a question into the air and within 10 minutes have a reply from an explorer in the far jungle. And the wonders of news transmission are being perfected steadily to even higher efficiency. Already one of the marvels of this machine age, the modern newspaper is still concentrating effort on improving its speed in covering news. Within the past two years, the city editor has taken on another mechanical assistant. Dictaphone-telephone hook-ups are now being used to cut down the time and expense of transmitting news over long distances.

This new mechanical combination is now an accepted, regular means employed by leading Australian newspapers for reporting news from distant points. Long distance telephone lines are used at prearranged times by the newspaper's correspondent. Dictaphones with amplifier mouthpieces are attached to the telephones at the receiving end in the newspaper offices. The reporter speaks in an evenly timed voice, at the rate of 100 words a minute. An attendant "listens in" to the voice coming in over the wires, and when the machine's wax cylinder is filled, he signals the sender, who pauses while the cylinder is changed.

The cylinders containing the news material are transcribed by a corps of operators, with the regular transcribing machine and earphones. The copy is then passed directly to the sub-editor. Formerly news from distant correspondents had to be rewritten before it was turned over to the sub-editor for copy-reading, since the sentences were in choppy, abbreviated form for economical telegraphing.

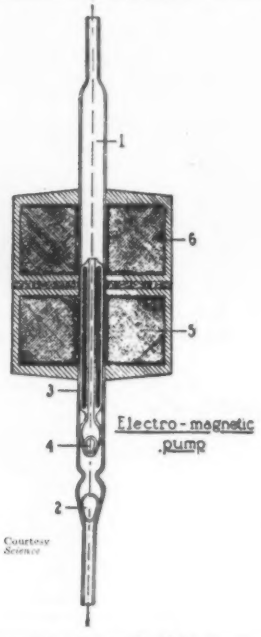
The new method of news transmission, according to the *Rockhampton Bulletin*, has shortened the former all-night period for receiving news to about one hour daily. Because the correspondent can be certain of sending in all his material in one hour instead of three or four, he can now take time to organize his news carefully to present it in finished style, so that the work of the copy desk in handling his copy is reduced practically to punctuation and headline writing. The *Bulletin* estimates that the cost of receiving 15,000 words per week by telegraph, working six nights, was 30 pounds, or about 150 dollars. The cost of the same service by the new hook-up is 12 pounds a week.

In the United States, as might be expected, this new combination of machines to speed up news has been applied first to market reports and sports news. Dictaphone-radio hook-ups last fall kept Oregon poultry raisers in close touch with pre-Thanksgiving market news, so that they were enabled to sell to the best possible advantage. Their hook-up was made in the office of the county agent, where were recorded market reports broadcast during the working hours when it was impracticable for the farmer to listen in at his radio. The cylinders which caught the news from the loud speaker were tran-

A section of the new dynamite plant at Mineral Springs, near Birmingham, Alabama

scribed into reports which reached the farmer within a few hours. This meant that he could plan his marketing from reports much less than a day old.

When the American derby took place last summer Clem McCarthy, nationally known turf authority, reported the racing



Fluids passing through this pump make contact with glass only

classic minute by minute over the radio. A receiving set in the composing room of the *Chicago Herald and Examiner* was hooked up for recording, and as the derby progressed, the story of each race was recorded on dictation cylinders in the newspaper office within the minute that it took place hundreds of miles away. This method of reporting, used in connection with the Sharkey-Stribling fight in Florida, speeded up the news so that newsboys crying the outcome of the fight met the homeward bound fans.

Huge Week's Sales of Airplanes

SALES of airplanes, engines, and gliders amounting to three quarters of a million dollars in a single week is the record established at the New York Air Show, which closed May 10, according to the Aeronautical Chamber of Commerce of America, Inc., sponsors of the show. The authenticity of the sales reports was vouched for in signed statements filed by exhibitors at the show. More than 120,000 people are said to have passed through the doors of Madison Square Garden while the show was in progress—another high record.

Flying school operators reported their biggest sale of flying school courses during a single week as a result of contacts made at the air show. Furthermore, thousands, inspired by reports of the show and by the flight of a fleet of 140 Navy planes, a number of Army planes, and 77 commercial planes over the city, took their first airplane rides from several of the flying fields near the city during the week of the show.

The sponsors of the show announce that another gigantic show will be held in the city next year.

An Electromagnetic Pump

DURING the course of some investigations in the Laboratories of the Rockefeller Institute for Medical Research, it became necessary to devise a pump which could be used to circulate sterile fluid in a system free from any rubber, metal, oil, grease, or cement. To fulfill these requirements, a pump has been constructed entirely of glass, in which the motion of the piston is actuated by electromagnetic forces.

The diagram shows the pump in cross section. The pump cylinder (1) is a glass tube which has a carefully ground valve (2) at its lower end. The piston (3) consists of two tubes with a soft iron core fused between them. The lower end of the piston has a valve (4) which is identically the same as the cylinder valve (2). Both valves close by gravity. The pump cylinder is surrounded by a lower solenoid (5) and an upper solenoid (6). Both solenoids are hooked up in separate circuits. By means of a three-pole, automatic mercury switch actuated by a rocking device, the electric current flows through the solenoids periodically in such a way that they are switched on and off, one after the other, with an intermediate state in which both solenoids are magnetized for a short time. Thus, a magnetic field is created inside the solenoids. The center of this field travels up and down periodically.

The iron core inside of the piston is attracted into the center of the magnetic field. The piston moves up and down continually, like the plunger of any pump. The up-stroke of the piston opens the cylinder valve (2) and closes the piston valve (4), while the down-stroke closes the cylinder valve and opens the piston valve. By this means, any fluid can be circulated or transferred.

The pump has many practical applications, especially where it is necessary to maintain sterility. It can also be employed for blood, and for strong acids, alkalis, or other dangerous fluids.—Heinz Rosenberger, in *Science*.

A Marine Airport

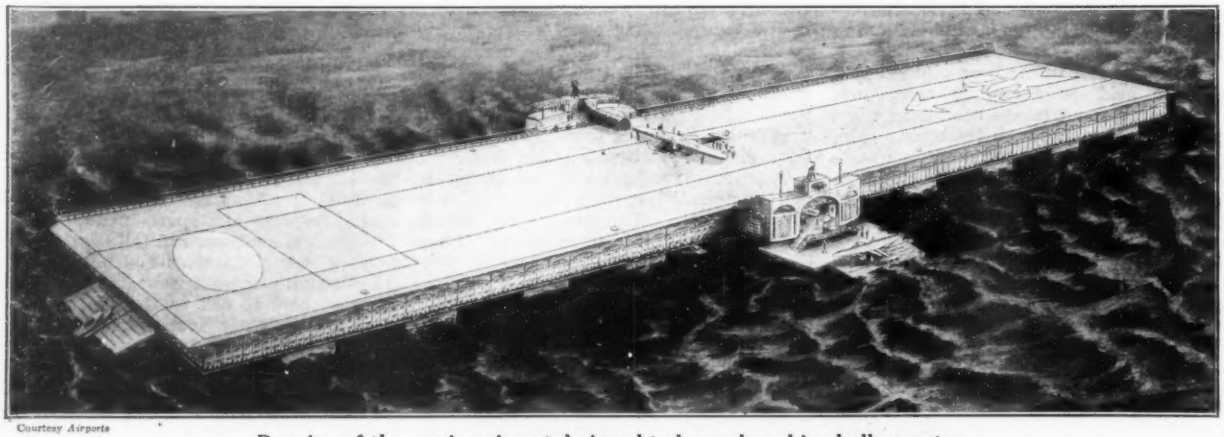
THE Engineering Service of the American Institute of Steel Construction has worked out a very interesting design of a floating marine airdrome for use near a big city. It was described in a recent issue of *Airports*.

Utilizing the experience of builders of steel railroad-car barges, the flotation principle has been applied to serve as the foundation for the drome. Although the structure weighs 7500 tons, its draft of water is but seven feet.

With this shallow draft the marine airdrome could be used near large cities, as for example in the waters of the upper bay of New York. It would then be comparatively near the center of the metropolitan area. The great problem of accessibility to large cities would be at least partially solved.

The top deck of the airdrome would have dimensions of 1000 by 200 feet. Since the airdrome could be so anchored as to head into the prevailing wind at any time, these dimensions would provide sufficient landing and get-away runs for all but the most heavily loaded aircraft. These dimensions would be greater than those available on the Navy's aircraft carriers. The deck would be entirely clear of obstructions. In the middle of each side there would be a wing bulging out about 25 feet for the convenience of passengers and visitors. The flood-lighting system would be such that the beam would be thrown into the wind or following the direction of the landing plane. The approaches for a mile or two in both directions would be illuminated by a series of lights that could easily be mounted on buoys 500 feet apart.

Aside from serving as floating elements,



Courtesy *Airports*

Drawing of the marine airport designed to be anchored in shallow water

the pontoons are to house the heat, light, and power machinery. To keep the decks clear and to hasten take-offs, two heavy-duty elevators are to connect the two decks of the airdrome. The lower or service deck is to have an area of approximately 180,000 square feet, with an overhead clearance of 21 feet. Across the middle of the service deck there is to be a terminal building providing every airport facility including a hotel, waiting rooms, restaurant, offices, and other facilities. At each end of the structure a wide terrace is to be provided which would connect with a seaplane float below. Seaplane or amphibian facilities would thus be provided.

A novel and simple form of anchorage has been designed permitting a dual control, so that the airdrome can be headed into the wind at all times. The primary anchorage is arranged so that the structure will revolve within a radius of 600 feet.

While the marine airdome is still only in the "idea" stage, it seems feasible and plausible.—*A. K.*

Talkies for the Hard of Hearing

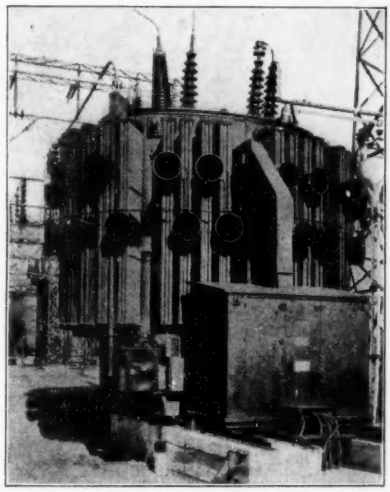
THE person who is hard of hearing has a most difficult existence, since he can not indulge in any form of entertainment or human activity in which the sense of hearing plays a prominent role. Recently a campaign has been undertaken in this country by the American Federation of Organizations for the Hard of Hearing to cause theaters, churches, music halls, and motion picture houses in which the talkies have replaced the silent pictures to equip some of the seats with plug-ins for hearing devices. Several theaters have already installed such plug-ins.

In the device installed in one London theater by L. E. Coussell, an engineer, a microphone is placed slightly in advance of and immediately below one of the loud speakers. There is a cable lead at the back of the screen which is taken from the microphone to a plug point on the stage, and further telephone cable is then connected with a special three-valve amplifier. A second line runs from the amplifier to a block of seats in the auditorium. This block is wired with armored cable and each seat hsa a telephone jack under the arm rest. The listening set consists of a single ear phone on a handle with a local volume control. The flexible cord of the ear phone terminates in a telephone plug, which lifts into the jack already mentioned. Each hearer can control the volume of sound to suit his own needs. The results were so satisfactory that similar equipment has been installed in other theaters.

In this country the need of hearing devices is much greater and the campaign now being lead by Mrs. Louise Pelton of the Chicago League for the Hard of Hearing is tending toward the establishment of plug-ins. Already 25 out of 100 churches in Chicago are equipped and several motion picture houses are installing equipment.—*M. F.*

Cooling Transformers with Fans

A RECENT development in increasing the capacity or rating of a transformer involves the placing of fans about the radiators. The accompanying photograph shows one of a bank of three Westinghouse transformers installed at the Plymouth Meeting substation of the Philadelphia Electric Company. Each conical shaped projection houses a fan, or blower, which keeps a draft of air circulating through the radiators. The rating of this bank of transformers without the fans was 100,000 KVA; the capacity with fans as shown is 130,000—an increase of 30 percent.

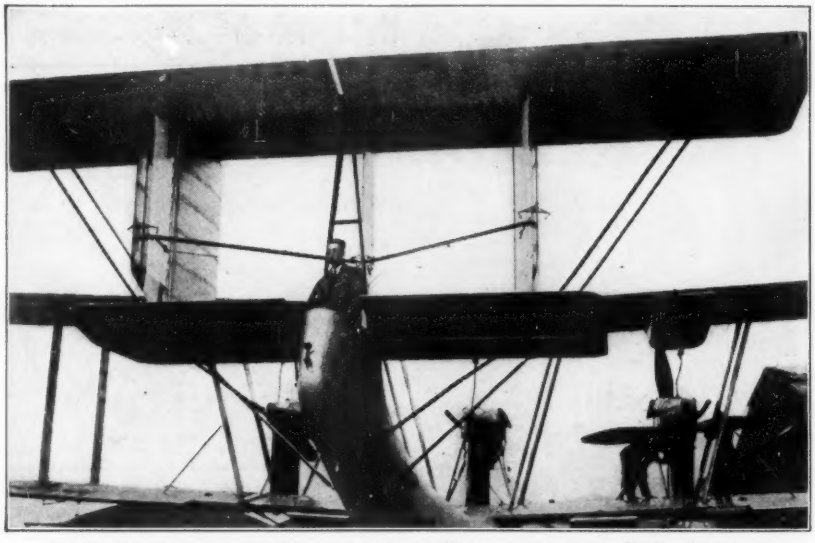


The conical projections on the side of this transformer each contain a cooling air fan or blower

A Gunner at the Tail

THE large reconnaissance flying boats of the American and British navies are airworthy and seaworthy craft, capable of cruising long distances without the support of surface vessels, and are well equipped and well armed. Nevertheless, a large flying boat with many guns may be no match in single combat with a small combat machine, because the latter is so maneuverable and so fast. The best protection for the large and less maneuverable craft is to be able to fire in every direction.

The Blackburn Company of England, has recently built a large all-metal boat, equipped with three Rolls Royce engines of over 600 horsepower each, in which an attempt has been made to give perfect fire range in the rear—where a large plane is most vulnerable—by installing a gunner's cockpit in the extreme end of the hull, aft of the tail surfaces. It is to be hoped that the gunner can easily make his way through the hull to a more central location. All the oscillations of the plane are so magnified at this distance from the center of gravity that even a hardened aviator might at times feel "squeamish.—*A. K.*



Protecting the vulnerable point. A machine gun in the tail of a bomber

To Destroy Poison Ivy

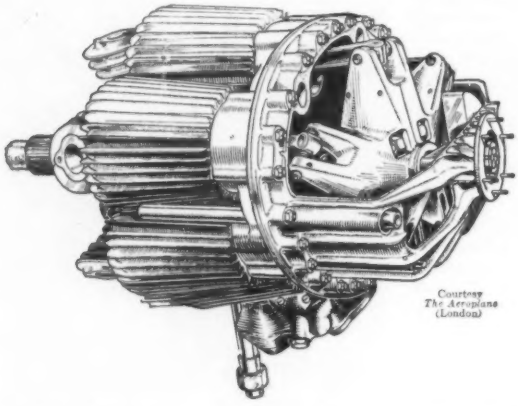
LOW-grade kerosene or crude oil, sprayed on the poison ivy vine, suffocates the plant tissues and causes destructive chemical action so that the plant dies. High-grade kerosene is not so good for it volatilizes too rapidly. Best results are obtained in hot weather. If possible, it is also advisable to cut the stems near the ground and repeat the cutting frequently until the plants are starved. Through lack of foliage, the plant, once it has used up the food stored in the roots, cannot manufacture more food for re-growth.

Loss of Hair Attributed to Deficient Diet

IF your hair is falling out it may be a sign that your diet is deficient in Vitamin G, the latest addition to the recognized family of diet principles introduced to a recent meeting of the American Chemical Society by Professor H. C. Sherman of Columbia University. Although Vitamin G has been identified for only about one year, physiological chemists at Columbia have conducted elaborate experiments of the effects of its presence or absence in the diet of rats. In these animals the vitamin is directly connected with growth. Lack of it, said Dr. Sherman, may retard growth, stop it, or in extreme cases cause death. In some rats the shortage caused premature old age. Loss of hair is one of its most commonplace danger signals. Its lack is suspected as a cause of pellagra.

"The growth requirements of rats," he said, "presumably apply to other mammals also. Vitamin G must play a prominent part in any adequately comprehensive conception of food values from now on."

Still another member of the vitamin family is suspected to be hiding behind "G." Dr. Sherman called it the "new factor" stating that it, too, is important for growth, and that evidences of its presence have been detected by several other laboratories in addition to Columbia's. This new factor is abundant in milk and presumably in meat. Vitamin "G" is abundant in milk and leaves, such as spinach, kale, and cabbage. It appears moderately, Dr. Sherman said, in meat and eggs.—*A. E. B.*



Courtesy *The Aeroplane* (London)

In this view of the Redrup axial engine for aircraft, the five-pointed star member which rotates on the Z crank (the special form of the crankshaft) may be seen at the right end. The cylinders lie parallel to the center-line of crankshaft rotation, as explained in the accompanying text

The Redrup Axial Engine

THE air-cooled engine of the star, or radial, type is always being criticized on the grounds that it impedes the pilot's vision because of its large over-all diameter and projecting cylinders, and because its head resistance is large. To make the engine more compact and to reduce the head resistance, the suggestion has often been made that the cylinders should be so arranged as to be parallel to the crankshaft, and quite near to the crankshaft center. The great difficulty in such an arrangement is the mechanical one of converting the reciprocating motion of the piston into the rotary motion of the crankshaft. The Redrup-Level axial engine, recently described in *The Aeroplane* (London), seems to offer an ingenious and successful solution of the difficulty, avoiding excessive rubbing velocities and highly-loaded bearing surfaces.

It can be seen from the drawings that the crankshaft, which lies along the axis of the engine, is carried by two roller-bearings and one ball-bearing. The crank-pin is one of the special features of the engine. Instead of being eccentric and parallel to the shaft, it is set at an angle and actually crosses the center-line of the crankshaft, and is called a Z crank.

On the Z crank is a five-pointed star-member, each point of which is attached to the connecting rods of the five cylinders through a neat form of universal joint. The connecting rods carry a universal joint at their piston ends also. The star-member has two white metal bearings in which the Z crank revolves.

The easiest way to understand the motion of the star-member is to consider the instant when the top cylinder has just fired and the piston has completed half its down-stroke. There is obviously a compression force along one side of that particular arm of the star, tending to push the crank down and around.

The star-member must be allowed to oscillate but be prevented from turning. This is accomplished by a stabilizing fork or torque rod. This rod has a fork at one end which is hinged to the inside of the star-member. The axis of the hinge passes through the middle of the crank-pin and is always at right angles to the axis of the pin as the torque-tube is carried in a self-aligning journal bearing at the bottom of the crankcase.

By this arrangement, the star-member is free to oscillate about the hinge of the fork, and, as the fork can twist in its journal bearing, the star-member can also twist about a vertical axis. Thus it can follow the wobbling motion caused by the rotation of the crankshaft and yet allow the full torque-reaction of the engine to be taken through the torque-rod to the crankcase.

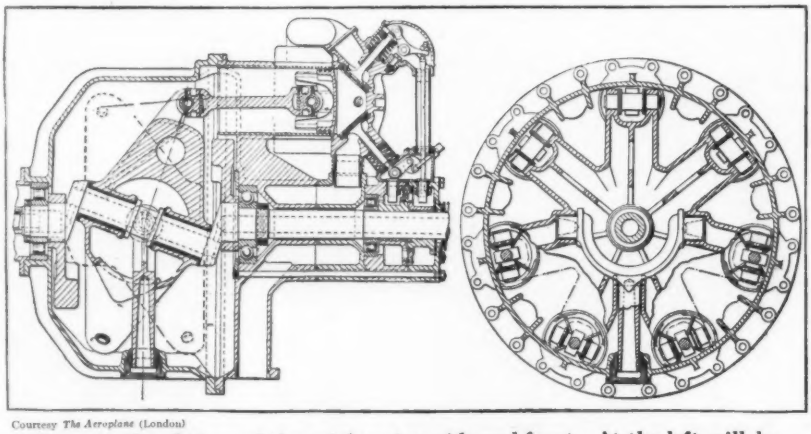
There are three valves in each head, one exhaust and two inlet. They are of normal type and are operated by rocker-arms on the cylinder heads. These rockers are moved by push-rods with hardened steel balls at both ends.

The rods are operated by roller-ended tappets which are moved up and down by two-lobed cams running at one quarter engine-speed and driven in the direction reverse to that of the engine by epicyclic gearing off the crankshaft.

In other respects the engine is normal in design.

The frontal area for the 60 horsepower engine has a diameter of only 18 inches. This opens many possibilities for use in a twin-engine machine, with engines mounted on the wings. The weight of the engine will be about 160 pounds or 2.6 pounds per horsepower.

The further development of the Redrup axial engine will be watched with considerable interest.—*A. K.*



Courtesy *The Aeroplane* (London)

Cross-sectional views of the axial engine, side and front. At the left will be noted the manner in which the novel star member "rides" on the Z crank

Would "Perfume" Gas to Deter Suicides

"SOMEBODY is always taking the joy out of life," and now the chemist threatens to take the comfort out of dying, by mixing formalin with illuminating gas so that suicide by asphixiation will be less attractive. The interesting suggestion that formalin might be mixed with coal gas as a deterrent to suicides was made by Dr. F. J. Waldo, the London city coroner, recently. Dr. Waldo declared that the formalin admixture would make the would-be suicide's eyes water and perhaps also cause him or her to sneeze. As suicide is so often the result of a momentary brainstorm, the delay thus caused would probably give the would-be suicide time to think better of the idea.—*A. E. B.*

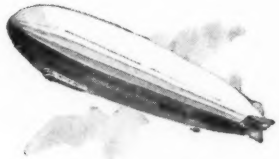
If You Ever Wash Dishes You've Wondered About This

EVEN editors have to wash the dishes occasionally, and it was in the performance of this domestic chore the other evening that we got to wondering what makes those silvery black marks on the china that simply will not wash off. By a queer coincidence, we picked up a *Technical News Bulletin* of the United States Bureau of Standards the next day, and learned that others have wondered about the same thing, and that the Bureau has investigated the phenomenon with interesting results.

It is reported that when such objects as silver-plated knives are drawn across tableware, a mark results which can not be removed by washing. The bureau has carried on certain work which would seem to indicate that the trouble is caused by a slight, almost inappreciable roughening of the surface of the ware because of its being fired in the presence of gases from sulfur in the kiln.

This was shown to be the case by taking some pieces of ware from a manufacturer which did not show any cutlery marking and giving them a firing in an electric muffle into which measured amounts of sulfur dioxide were introduced. When as little as 0.0625 percent by volume of this

CONQUERING THE FOE ... *that turned back a Zeppelin*

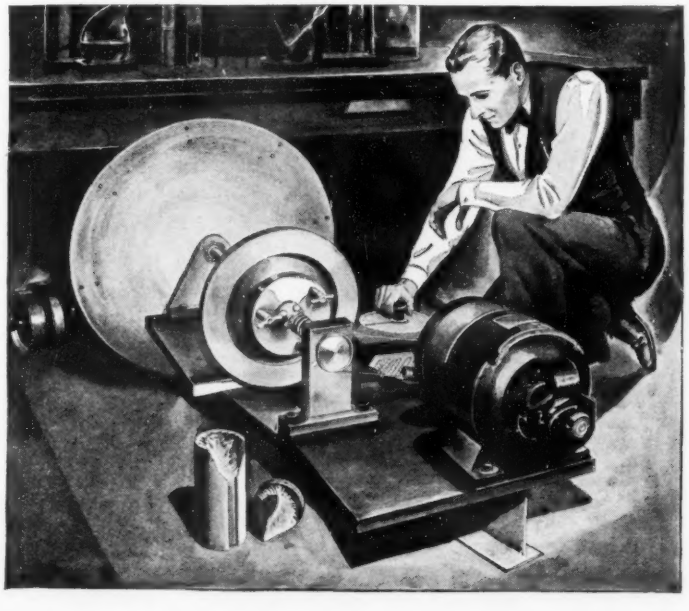


A giant Zeppelin not long ago started across the Atlantic. Hardly was it well under way, when, one by one, the drive shafts of four of its five engines cracked and went out of action. The great air ship turned back and landed—reaching its port just in time, as mechanics soon discovered, for the fifth shaft was then almost at the breaking point.

Vibration which turned back this huge Zeppelin is a foe to every modern high speed machine. In the Westinghouse research laboratories at East Pittsburgh vibration has been put on the stand to disclose its own secrets. Its ways have been charted. Its behavior has been reduced to mathematical formulas which engineers can now use in designing machinery to operate safely and reliably at the high speeds which modern industry demands.

Not only in electrical details of modern machinery, but in mechanical details as well, Westinghouse carries on its work of research and improvement—helping you to have more by making machines capable of doing more.

The results of Westinghouse research actively serve you in mines and factories, theaters, homes, stores, and offices—wherever the work or recreation of the modern world is carried on.



Tune in the Westinghouse Salute over WJZ and the coast-to-coast network, every Tuesday evening.

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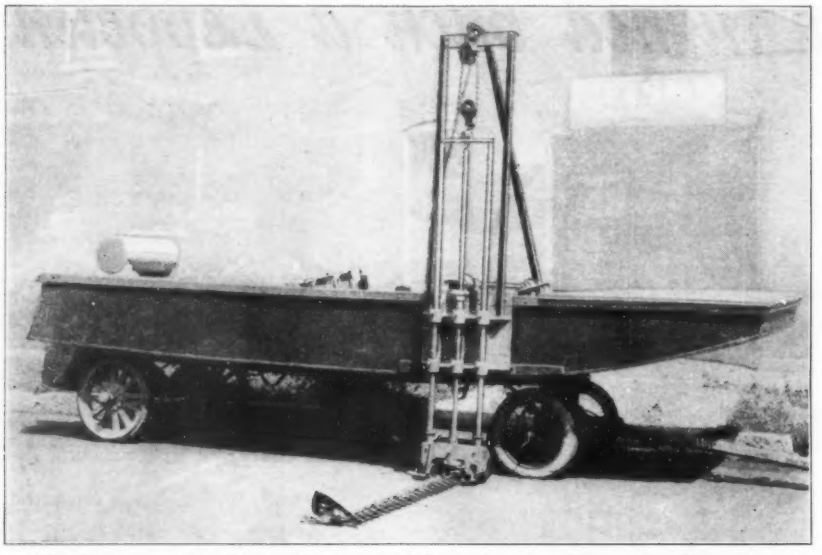
gas was introduced into the muffle the ware, on removal, gave ready evidences of cutlery marking.

It was further found that on treating the ware, fired as described above, with solutions of ammonium acetate, lead sulfate was dissolved from the surface of the glaze.



The lily mower which cuts the stems of these plants under water. It consists of a boat (here shown on wheels) with an adjustable mower attachment

On the removal of this material by such a process as buffing, the ware no longer would mark. Samples of enameled iron similarly fired also developed a condition which resulted in cutlery marking. Commercial practices would seem to confirm the above result. One manufacturer, in substituting an electric muffle for firing his decorated ware, obtained a product that was no longer susceptible to cutlery marking. The fact, however, that this trouble was due to the formation of an extremely thin layer of lead sulfate seems not to have been noted previously.—*A. E. B.*

Steel Industry Consumes Most of Our Manganese

ABOUT 95 percent of the manganese consumed in the United States is used in the manufacture of steel, the principal base alloys being ferro-manganese and spiegeleisen, according to the United States Bureau of Mines. There is considerable manganese in many varieties of steel, including spring steels, plate steels, structural bar types, rail steels, and various steels used in the manufacture of wheels, tires, axles, armor plate, and other products of a similar nature.

Formerly manganese steels containing 1 to 1.5 percent manganese were classed as good-grade Bessemer steel, but recently they have been classified as alloy steels and have been put on the market under various trade names. Such steels have excellent tensile strength and ductility with high resistance to abrasion, and are used extensively in Caterpillar shoes, truck wheels, and other appliances where relatively low cost and high quality are required.

A manganese steel containing 12 to 14 percent manganese is used in castings for ball mills, pulverizing machinery, and rock-crusher jaws because of its resistance to impact wear and because of its hardness. Manganese is also an important constituent of nickel and molybdenum steels. Molybdenum steels usually contain 0.2 to 0.4 percent molybdenum and 1 to 1.5 percent manganese. Nickel-manganese steel usually contains approximately 1 percent nickel, 1 to 1.5 percent manganese, and 0.3 to 0.4 percent carbon. The nickel adds ductility and toughness but increases the cost.—*A. E. B.*

Underwater Lily Mower

THE problem of mowing a heavy growth of pond lilies from a 50-acre reservoir in Earlington, Kentucky, resulted in the ingenious "boat mower," shown in the accompanying illustration. The growth of lilies was satisfactorily eradicated with the machine shown and a knotty problem thus was solved.

The flat-bottom scow is driven by a 35 horsepower Universal motor, which operates the cutting mechanism as well as propels the boat. The flywheel of the engine was removed and replaced by a spur gear. Between the cutter bar and the motor were placed an automobile clutch and transmission gear so that the boat could be propelled without the action of the cutter, and also to permit different speeds without having to operate the cutter bar.

The cutter bar is adjustable for different depths of water and performs at varying depths of from 18 inches to 60 inches below the surface. The middle bar on the carriage is the driving shaft on which the bevel bar slides up and down to drive the shaft by means of a key which fits in a groove. The bottom shaft is connected to an eccentric and connecting rod which gives the necessary oscillating motion. The entire gearing was arranged to drive the cutter at a slightly slower speed than the normal speed of such a bar on an ordinary mowing machine. The cutting mechanism is raised and lowered by a differential pulley.

The strange craft has been christened "The Lily Nipper."

Page From This Magazine Does Duty as Wall Paper for 78 Years

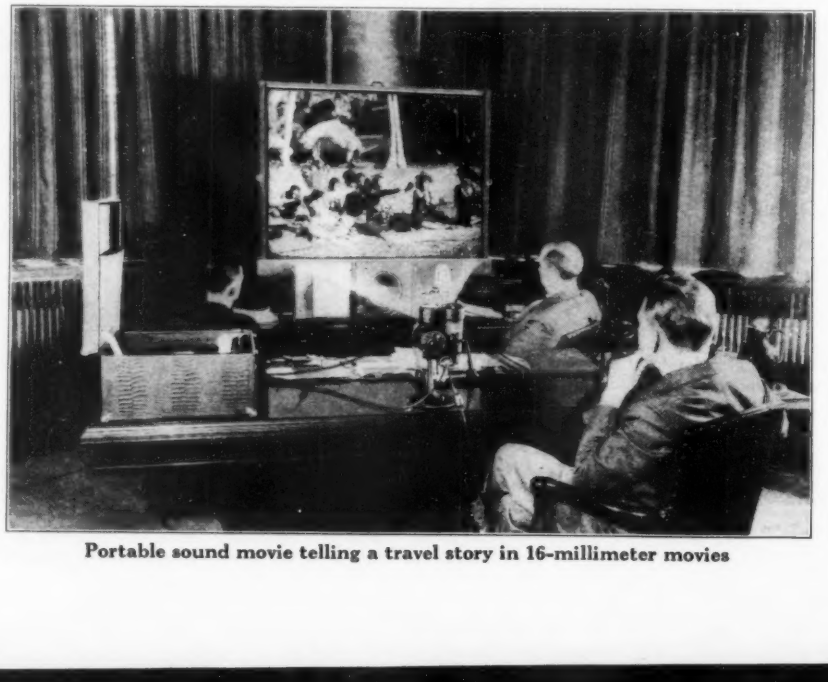
THE following item was clipped from a recent issue of *The Arcata Union*, of Arcata, California:

"While tearing down an old wall in the Vassaide Building a few days ago, carpenter Collins came across a board with a piece of newspaper attached to it which had been doing duty as wallpaper. The fragment was a portion of the SCIENTIFIC AMERICAN dated 1852 and was put in use when wall paper was scarce in Arcata."

Portable Sound Movie

A DISTINCT innovation in the motion picture field—a thoroughly practical portable equipment for the presentation of sound movies—was recently announced by the Bell and Howell Company. Amateur projectionists will be particularly interested to know that 16-millimeter films are exclusively used with this newly developed equipment.

The complete outfit consists of three small units which can be easily carried from place to place. Any Filmo projector



Portable sound movie telling a travel story in 16-millimeter movies

can be adapted for use in this equipment. A standard 16-inch phonograph record of the 33⅓ revolutions-per-minute type, is synchronized with the projected pictures. The projector, player unit, and a dynamic speaker each are contained in a separate case, and can be quickly set up and easily operated.

The Filmo projector and playing unit are driven by separate motors, each motor designed for its special purpose. The two units, the projector and the playing unit, are then coupled together mechanically by means of a flexible shaft so that positive synchronization is assured, regardless of the length of the picture or record.

Diesel Engined Ford Tri-motor Plane

SEVERAL airplane manufacturers are offering their planes equipped either with a gasoline motor or the Packard airplane Diesel engine, the purchaser to have his choice. Of these, according to *Barron's*, The Ford Motor Company, in its advertising pamphlets of the Ford tri-motor plane powered by Packard Diesel engines, says fuel consumption for each engine runs about 10 gallons an hour, which at nine cents a gallon brings total fuel cost to around 3 dollars an hour, a saving in fuel cost of more than 60 percent. Diesel engines decrease both cost and quantity of fuel necessary and use about 20 percent fewer gallons per horsepower than gasoline engines, it is pointed out.

Paper Mulches for Growing Plants

"ONE thing leads to another" may be a conversational platitude but it certainly describes the process by which one enterprising home gardener profited. A recent letter from Mr. B. K. Smith, of Newcastle, Indiana, states that he read the article "Farming Under Paper" in our August, 1928, issue and then during the summer of 1929 experimented in a small way with paper mulches. Inasmuch as his experiences may prove of benefit to others, we quote below a letter which he sent to the *Newcastle Courier:*

"We have worked out a method that can be used for garden mulch around the plants. Last year we were growing green beans. When the drought came, their leaves began to wilt and were doing no good. The first row we tried soaking the ground around them thoroughly in the evening, then taking the first or second section of the *Indianapolis News* or a whole *Newcastle Courier*, folding them to fit between the rows, thus making packs of eight to 12 or more sheets thick. We laid them close to the plants on each side of the row like shingles, only reverse, commencing at the top of the grade, so that when it rained the water would run under the packs instead of over and off. We soaked the papers thoroughly and put dirt, stones or bricks on the upper corners to prevent wind from blowing them away.

"The first week this row began to thrive and bloom. The other rows not so treated began to die.

"We also tried medium asphalt roofing cut in strips. This did not do so good as the paper packs but better than none. We find several sheets of thin paper to be better than one heavier or roofing. Also the water runs off the roofing instead of

(*Please turn to page* 68)

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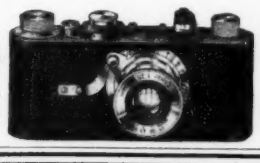

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For METHOD OF LOCATING THE SUN'S POSITION AND FOR THE RISING OF THE PLANET DISKS, SEE ACCOMPANYING TABLES.
THE ARROW THROUGH THE TWO STARS IN THE BOWL OF THE BIG DIPPER POINTS TO THE "NORTH STAR" THE STAR AT THE END OF THE HANDLE OF THE "LITTLE DIPPER"
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The Amateur Astronomer

A Monthly Department

THE amateur who aspires to make his own telescope is advised to begin on an instrument having a diameter of not more than six inches, as this is the most suitable size on which to get one's initial experience. Sets of materials, ready to use, may be had in this size for ten dollars, and the interesting work of grinding, polishing and figuring the mirrors should not occupy more than a dozen evenings.

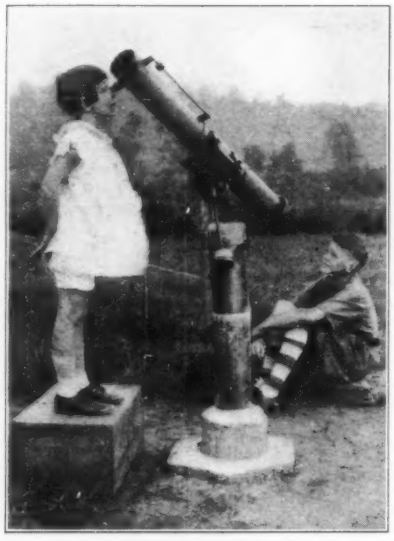
When a worker has completed a six-inch telescope, though it should magnify from 50 to 200 diameters and be the equal of a refracting telescope four inches in diameter

Nettell and his 10-inch

and costing 300 dollars or more—a real astronomical telescope—he is ready to tackle something larger. A 10-inch is about the ideal size for the average amateur ultimately to possess, representing a compromise between skill, pocketbook, and pipe dreams.

MR. RICHARD NETTELL, 155 North Boylston Street, Los Angeles, California, sends us a description and photograph of his 10-inch reflector. "I have made four or five telescopes before," he writes, "but this last effort of mine was made since I got the SCIENTIFIC AMERICAN instruction book 'Amateur Telescope Making.'

"The point I wanted to stress in my design was convenience and ease of observation and operation. The observer stands on the ground level, which is a great convenience for elderly or nervous people. The telescope is a tripod, take-down affair, as I have no room to keep it set up. The mirror is 10 inches in diameter, with a focal length of 130 inches. The tube is 11 inches in diameter and is eight feet long. At the upper end of the tube there is a three-inch flat, reflecting the rays back to the diagonal located opposite the eyepiece; making three reflecting surfaces in all. I appreciate the fact that by this design I lose some of the light, besides the loss through adding another reflecting surface, but I thought the convenience of standing on the ground more than compensated for that loss.



Lambert's four-inch

"The grinding and polishing were all done in the evenings, within three feet of our cook stove. The curve of the mirror, when I got through with polishing it, was as perfectly spherical as I could determine by the knife-edge shadow test; this with a room temperature drop of two degrees per hour. It showed in a slight degree the oblate spheroid form when the room temperature was even. All my previous mirrors had been more or less hyperbolical, and I wanted to avoid this if possible, so I estimated that the drop in temperature out-of-doors would give it the necessary parabolic form if I left it spherical.

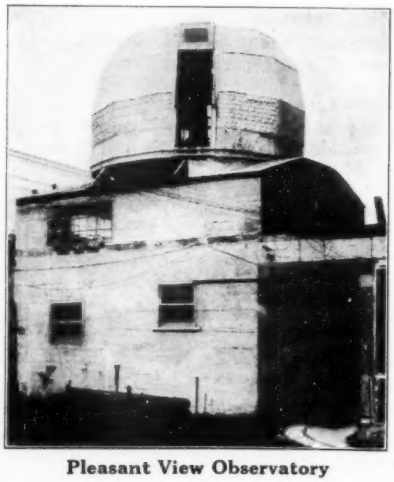
"In performance, my mirror, when testing it on distant bright terrestrial objects, gives fairly sharp definition when using a ⅛-inch focus eyepiece. That means a magnification of 650 diameters.

Staffa—Pyrex mirror

"The mounting is an equatorial, on a collapsible tripod, with a clock and weight drive. The pipe handle to carry it by, is also the finder."

Mr. Nettell evidently has succeeded in producing a good mirror despite proximity to a stove. Usually mirror making is done in the cellar, because there the temperature is most nearly uniform. Yet if the kitchen were also held uniform, and were about the same each night, the difficulty might not be great, for it is changing, not changed, temperature that causes trouble, as Ellison states (page 95, "Amateur Telescope Making"). One point to be considered is that ordinary pitch is too soft when used in a warm room. However, it may be boiled down to greater hardness, or resin may be mixed with it. At any rate, nothing succeeds like success, an adage which Mr. Nettell seems to have proved. He gets results from his telescope; it suits him; and that's that.

MR. ARTHUR W. LAMBERT, JR., Arcadia, Missouri, started on a four-inch mirror which he made from a disk of half-inch plate glass. His telescope is shown in one of the illustrations. Later he made a six-inch. He suggests that two mirrors should be started at the same time and "leap-frogged." He writes, "Let the worker get the first one ground and polished. Then mount it, silver it and begin to observe. He ought to get good results, at least intriguing and inspiring. Then let him try his hand on glass No. 2



Pleasant View Observatory

and bring this to some kind of figure. He will improve on his first, then can switch mirrors, and can begin again on No. 1. By the time he has it again in the mount, he will know something more than he did, and can begin again on No. 2. This can go on indefinitely, until perfection is attained.

"Another thing really surprised me. That was the real pleasures you can get from a poor glass. My first mirror, a four-inch made of windshield glass, is a very poor mirror. It brings a bright star to a

sort of cock-eyed focus. Yet it splits double stars, sees the moon very well, and performs in a surprisingly good manner. I have it mounted in the telescope shown in the enclosed picture. With this little fellow I easily find the ring nebula in Lyra."

COMMERCIAL polished plate glass is the material almost universally used for the mirrors of reflectors less than 12 inches in aperture, but a finer material, though a more costly one, is Pyrex. It has the advantage of a low coefficient of expansion—about one third that of glass. Where the amateur is skilled enough to produce a nearly perfect figure he may use this material to good advantage. Mr. George Staffa, 32 Front Street, Schenectady, N. Y., used it, and reports as follows:

"The mirror was ground according to instructions in 'Amateur Telescope Making', from two 7½-inch by ¾-inch disks of Pyrex, to a focal length of 54 inches. The polishing was done on a lap made of resin, beeswax, and paraffin which, while hot, was impregnated with rouge. This took only a short time, as the grinding had been done very thoroughly; in fact, the whole process of polishing and figuring took only about four hours. The mirror was polished to the very edge, as is shown by a microscope. I experienced none of the troubles described in 'Amateur Telescope Making.'

"The figure appears just the same after standing for half an hour as it was right after removing from the lap. Very good results were obtained on Saturn; also Jupiter, on which the markings can be seen quite in detail. There are a number of other telescope enthusiasts in Schenectady who have made mirrors of Pyrex."

MR. GEORGE H. CHASE, 28 Washington Square, Newport, Rhode Island, has erected an observatory on the roof of his shop. He writes:

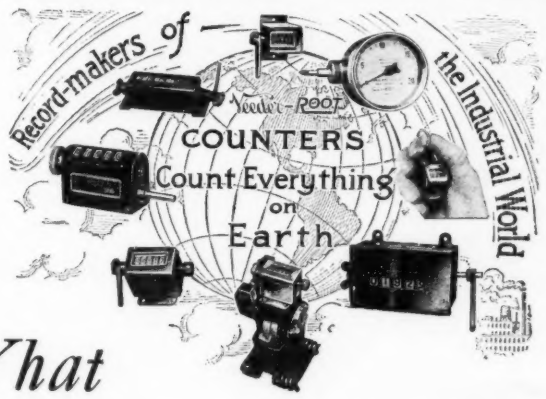
"The observatory shown in the photograph was built by Milton H. Chase and myself. The tower is built on top of a concrete workshop and is 14 feet in diameter. It rests on steel channels, and rolls around on eight wheels, being moved by an electric motor through a chain drive which passes around the outside of the tower.

"The electric motor control is on the post near the observer's seat. The framework of the tower is built of two-by-four joists and is covered with corrugated galvanized iron on the outside. The inside is covered with wall board. The present telescope is a six-inch, but provision has been made to take a 12-inch. This observatory is located at my home in Portsmouth, Rhode Island."

Speaking of amateurs' private observatories, *Popular Astronomy* (Northfield, Minnesota) began in January publishing an interesting series of descriptions of these, which is to run through the present year.

HOW about making a spectroheliosco pe? Since Dr. Hale contributed instructions for the job, ("A. T. M.," pages 180-202) a disappointingly small number have tackled it. One big obstacle is undoubtedly the cost of the grating, 125 dollars, but the remainder of the materials can be made by the amateur. In a recent letter Dr. Hale states, "You will be glad to know that spectroheliosco pes of the

(*Please turn to page* 70)



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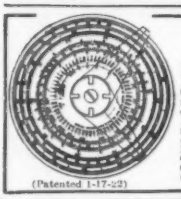

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The Scientific American Digest

(*Continued from page 65*)

under, as with the papers, and the packs will hold more moisture than the one sheet of roofing.

"We tried the paper packs on most of our garden last year on flowers, beets, onions, parsnips, cabbage, and tomatoes with good results. Probably we would have had better growth had we commenced using the papers before the ground dried out. As it was, however, the paper mulches proved their value.

"This year we expect to plant the seeds through the paper packs by using a sharp stick piercing the packs for plants to come through, first making a depression at the row so that the water will run to the plants."

Wood Impregnated with Metal

THERE has been developed during the last years by the German Institute for Steel Science in Duesseldorf a new procedure by which it has been made possible to fill the pores of wood with metal. The material which is thus produced combines to a certain degree the properties of metal as well as of wood. The new procedure is carried through by immersing wood in molten metal under pressure. The duration of this treatment and the temperature and pressure applied are of importance. All parts of the wood that are not filled by metal remain unchanged.

In a small trial plant, wood pieces 15 by 24 by 12 inches were thoroughly impregnated with metal. Infiltration may be limited to any desired depth. It has been found that the new material may be machined like ordinary wood. It is scarcely inflammable and does not enlarge its volume by taking up moisture. The appearance of the metallized wood is unique and it is expected that it will lend itself especially well to decorative purposes. It may also be suitable for lining journals and bearings, if a suitable metal is used for penetrating the wood. The new material was shown for the first time at a recent wood and timber exhibition in Berlin.—*A. E. B.*

New Solvents Eliminate Textile Problems

NUMEROUS textile problems have been greatly simplified or completely eliminated during the past year by the availability of certain of the new synthetic organic chemicals which formerly were not available on a commercial scale. Diethylene glycol has proven an almost ideal lubricant for wool spinning. Impregnation of the fiber with this chemical makes unnecessary the use of oils and as a consequence eliminates the costly operation of scouring for oil elimination after spinning. The glycol remains in the fibers of the spun yarn or fabric until the first treatment with either wash water or dye solution. At this point the glycol, which is water soluble, is removed without the necessity of another operation. New possibilities in the printing and dyeing of textiles have been made available by the use of Cellosolve and its derivatives as the medium for making solutions or pastes of dyes and colors. This group of solvents first developed for use in nitro-cellulose lacquers has thus found an extensive new application in textiles.—*A. E. B.*

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

ABRASIVE MATERIALS IN 1928, by Oliver Bowles. Grinding and polishing processes are of great importance. This pamphlet deals with the production of natural and artificial abrasives. *Superintendent of Public Documents, Washington, D. C.—5 cents (coin).*

STUDIES ON THE FALL ARMY WORM IN THE GULF COAST DISTRICT OF TEXAS (Technical Bulletin 138-T). Make application for this bulletin to the *Office of Information, Department of Agriculture, Washington, D. C.—Gratis.*

FOAMING OF MILK AND CREAM (Circular 108, United States Department of Agriculture) by C. S. Leete. Foaming often causes much loss of both product and labor and the present pamphlet is a practical treatise on the subject based on experiments. *Superintendent of Documents Washington, D. C.—5 cents (coin).*

ARCHITECTURAL ACOUSTICS (Circular of the Bureau of Standards No. 380) are not yet generally understood even by those who design auditoriums. In this circular the principles are stated and an example is worked out showing their practical application to the planning of a new auditorium. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

CHEMISTRY AND ANALYSIS OF THE PERMITTED COAL-TAR FOOD DYES (Department Bulletin No. 1390) by Joseph A. Ambler, W. F. Clarke, O. L. Evenson and H. Wales, deals with a subject in which there have been recent changes. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

AUTOMATIC LINE VOLTAGE REGULATION is a folder containing practical information on this subject as related to radio receiving set operation. *Clarostat Mfg. Co., 285-7 North Sixth Street, Brooklyn, N. Y.—Gratis.*

WALL DIAGRAMS OF ELECTRO-MAGNETIC WAVES. A heavy paper chart 22 inches high by 72 inches wide, presenting in clear diagrammatic form the 62 known octaves of ether waves, including cosmic rays, X rays, ultra-violet rays, visible light,

infra-red rays, and Hertzian waves, with summarized data on each—frequency per second, wavelength, how generated, and how detected. Just the thing for the student of the new physics. *John Murray, publisher, 50 Albemarle St., London W 1, England.—Unmounted 4/6 net. On linen, with rollers, 12/6 net.*

PHOTO CELLS. A loose-leaf pamphlet which will be added to from time to time. First release includes photoelectric effects, operation of cells, applications, and circuits.—*Jenkins Television Company, 346 Claremont Ave., Jersey City, N. J.—25 cents.*

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The Amateur Astronomer

(*Continued from page* 67)

type shown in my article are already in use at Pomona College, California; the University of South Dakota; the University of Michigan; Yerkes Observatory; Ohio State University; Vassar College; the Royal Observatory at Greenwich; the Astrophysical Observatory at Arcetri, Florence; the American College at Beirut, Syria; the Government Observatory at Canberra, Australia; and the Observatory at Samoa. Others have been ordered for use in Chicago, England (2), and China, and two native Indians in Madras (one an amateur) are building outfits for themselves." Isn't it time more amateurs jumped into this interesting game? Thus far, five American amateurs have nibbled at it, and of these some are believed definitely to be "hooked." The blueprints cost only a dollar and a half. Reread Dr. Hale's chapters, also the *Astrophysical Journal* for December, 1929, and see whether these do not make you want a spectrohelioscope.—*A. G. I., Tel. Ed.*

Our Point of View

Analyzing the Naval Treaty

(*Continued from page* 16)

of the Japanese delegation was buttressed by three very solid factors; first, they attended a conference jointly arranged by Great Britain and the United States, and as guests were under no obligation to make the party a success; secondly, since 1922, in submarines, they had outbuilt both Great Britain and the United States and possessed more modern submarines than any other state at the Conference, nor had they weakened their position by advocating the abolition of submarines as weapons of war; thirdly, during the same period they had outbuilt the United States in cruisers, had built up to a 9 to 6 ratio in destroyers with Great Britain, and were fast attaining a 5 to 3 ratio with us in destroyers, the only category in which we had full strength.

The continuous and comprehensive naval program of Japan since 1922 has only one modern counterpart in time of peace, that of Germany prior to 1914, and it has been carried out despite financial difficulties and the destruction of Yokohama and part of Tokio by earthquakes. This vast naval program would be no proper concern of ours except for the fact that in Washington, in 1922, we scrapped our capital ships and agreed to limit the fortifications of our Far Eastern possessions when we believed the 5 to 3 ratio with Japan would be extended to all categories of ships. Now, by the provisions of the London treaty we concede parity to Japan in submarines, a 10 to 7 ratio in destroyers, and a 10 to 7 ratio in six-inch gun cruisers. As a climax, Japan expressly reserves the right, at the end of the treaty period, to reopen the question of further increasing her ratio of eight-inch gun cruisers to 10 to 7.

At present we have only a 5 to 3 ratio in capital ships because, although granted a 5 to 3 ratio in aircraft carriers, actually we have built only 66,000 tons of modern aircraft carriers against 61,270 tons for Japan, and we have authorized one more carrier of 13,800 tons while Japan is building one of 7600 tons. Thus, unless we accelerate our building program from now until 1936, we will be practically equal to Japan in modern aircraft carriers, and inferior in cruisers. We will have only a 10 to 7 ratio in destroyers, and all of Japan's destroyers will be modern post-war tonnage, while the bulk of ours were designed and hurriedly constructed during the World War to meet the German submarine menace.

Our position relative to Japan during the life of this treaty may be recapitulated: in capital ships we will have a 5 to 3 ratio; we will have a 10 to 7 *tonnage* ratio in destroyers, but our destroyers are all over 10 years old, while Japan's are all under 10 years, and one half are less than five years old; Japan has eight eight-inch gun cruisers in commission, we have one; by the end of 1931 we will have eight, Japan will then have 10; by the end of 1932 we will have 11 and Japan will have 12; by 1936 we will finally attain a 5 to 3 ratio in eight-inch gun cruisers. In six-inch gun cruisers, Japan today has 20 of 95,000 tons against our 10 of 70,500 tons. By the terms of the treaty if we build 18 eight-inch gun cruisers we can build six-inch gun cruisers only in the ratio of 10 to 7. Provided Congress acts promptly and we lay down four six-inch gun cruisers per year, it will be 1935, one year before the treaty expires, before we will attain a 10 to 7 ratio in six-inch gun cruisers. In modern aircraft carriers we have a scant margin on Japan at present, and unless we accelerate our building program during the life of the treaty, it will remain about 8 to 7. In modern submarines we are at present inferior to Japan and by the treaty she concedes us parity.

THUS, by resolutely carrying out her comprehensive building program between 1922 and 1930, Japan was able to send to the London Conference a delegation in a position to insist upon her demands. This position was rendered impregnable by the solid support the Japanese government and people gave their delegation. No group of Japanese pacifists weakened the arguments of their delegation with demands for naval reduction. As a result, Japan obtained practically every item in her demands, and yet following an ancient custom, the leader of her delegation, in his report to the Emperor, deplored his unworthy talents that so inadequately represented his country's case; while our delegation returned almost jubilant because the Japanese did not insist at this time on a 10 to 7 ratio in eight-inch gun cruisers.

The Japanese press states that Admiral Kato, Minister of Marine, strenuously opposed any concessions, and made at least one personal appeal to the Emperor to overrule the decision of the Government. This effort failed, but to placate the Navy Department, the Cabinet promised to find money for the following new projects:—

(a) An increase in the air force from 17 air battalions to 20 battalions.

(b) Building of some special service ships (types unspecified).

(c) Strengthening of fortifications.

(d) Increase of expenditures on account of the upkeep and repair of ships.

In short, the Japanese government will divert to other naval and military measures the money saved by the Conference.

The Japanese press also explains to the Japanese people that their government

felt obliged to yield to Great Britain and the United States, lest the resulting estrangement between Japan and these two countries produce serious effects on Japan's international position, both politically and economically. One paper emphasizes the important fact that if the Conference failed and replacements of capital ships began next year under the terms of the Washington Treaty, Japan would have to find 75,000,000 dollars for building purposes which would necessitate still higher taxes. Finally the Foreign Office reminds the Japanese public that although under the compromise plan Japan's ratio was fixed at 62 percent, Japan's actual ratio up to 1936 would be 72 percent and that she had specifically reserved the right to restate her demands at the next conference.

It seems patent, therefore, that the small abatement Japan made in her total claims was due to her apprehension of the political and economic consequences if she offended both Great Britain and the United States, to her belief that a total failure of the conference would start battleship replacements in 1931 which she could not afford, and to the knowledge that during the life of the treaty she would actually have a 70 percent ratio in big cruisers. Having made this small concession it is significant that her government, to appease her Navy Department, authorized the Finance Minister to promise increased expenditures in the categories not limited. It seems plain, therefore, that just as Japan diverted the money saved by the limitation of capital ships in 1922 into cruisers, destroyers and submarines, she now intends to devote the money saved by the limitation of the smaller categories into increasing her air force, building special-type vessels, expending more money on the upkeep of vessels already built, and, finally, increasing her fortifications. There is a little irony in this last item, for on the presumption of a 5-to-3 naval ratio we have promised not to increase any of our fortifications west of Honolulu.

WE can find no fault with Japan for nicely adjusting her foreign affairs and her naval strength, nor for supporting as large an army and navy as her finances will bear. Many Japanese still alive can remember their two wars with China and Russia whereby Japan established her present proud position in the Far East; it is natural they should prefer to trust their future to their own military strength rather than to international agreements. For this reason they patiently submit to severe taxation before they will reduce the efficiency of their armed force. We would remind Americans, however, that the 5-to-3 ratio with Japan exists only in capital ships, that opulence is not military strength, and commercial supremacy is no safe substitute for armies and navies.

On the credit side of the Conference, we place the removal of much of the previous friction between Great Britain and our country. We believe the great majority of the people of Great Britain have finally reconciled themselves to a naval parity with the United States and, while Americans properly regard that action as due our position and responsibilities as a world power, we should remember that for the first time since attaining sea supremacy, Great Britain has peacefully conceded another nation naval parity. Our relations with Great Britain during the next decade can be stabilized better on the basis of parity than on any other ratio. We have fought against her in two wars; we have been to the brink of war with her on at least two other occasions; during the World War we fought shoulder to shoulder with her; and we know better than any other nation that she can be a formidable foe or a faithful friend on land and sea. We have no conflicting interests with the British people that cannot be arbitrated and we have a common background of language, literature, and self-government. The manful manner in which they are meeting their post-war difficulties deserves all praise, and Americans do not enjoy haggling with them over cruisers or disputing over the technicalities of gun power.

Great Britain cannot ignore the European situation; the simple solution is for us to obtain parity upward to the minimum of her necessities and to cease our insistence that she reduce her building program to satisfy the wishes of our pacifists. This statesmanlike procedure would not only benefit our relations with Great Britain, but it would enable us to safeguard our world-wide commerce and meet our responsibilities in the Far East—and the few million dollars per year additional cost will be well spent.

REGARDLESS of its imperfections, the treaty should be ratified, unless the Senate discovers some technical clause that may need a clarifying reservation. The Congress and the Administration should then promptly inaugurate a six-year building program that will place our fleet on a parity with Great Britain and in its allowed ratio with Japan. Unless Congress does this, we are in the untenable position of demanding that other nations restrict their building programs because we are too penurious to spend money on our fleet. Now is an excellent time to begin building, for it will stimulate the steel and shipbuilding companies and give work to the numerous skilled artisans whose services are necessary to create a modern man-of-war and all its accessories. Practically every industry in the country would benefit.

We repeat that Congress should adopt a continuous and comprehensive naval program that will raise our fleet to the maximum treaty strength by 1936 and maintain it at that position without the frequent fluctuations that prevent economy and efficiency in our naval establishment; for, having settled their continental interior, Americans are returning to the ocean that nourished and sustained their seafaring ancestors until the forests were cleared and farming commenced. Shipbuilding was our first great industry; our merchantmen carried the commerce of Europe and Asia when our factories were still in our homes and our railways unbuilt. Our factories now produce more than we can consume; an extraordinarily efficient railway system deposits our enormous foreign trade on our wharves to load upon *foreign* merchantmen. We are taking measures to revive our merchant marine so that we will no longer be dependent upon foreign carriers, and we should not delay providing and maintaining a navy that will protect our citizens and our foreign trade in all parts of the world. This done, Americans can continue to go about their peaceful tasks, envying no other people their prosperity, avoiding foreign political entanglements, and developing friendly commercial ties with the whole world.

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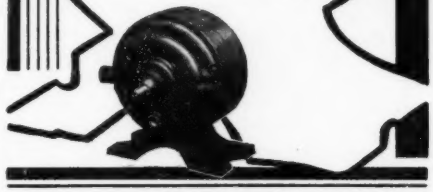

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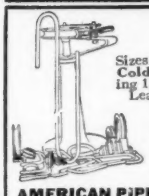

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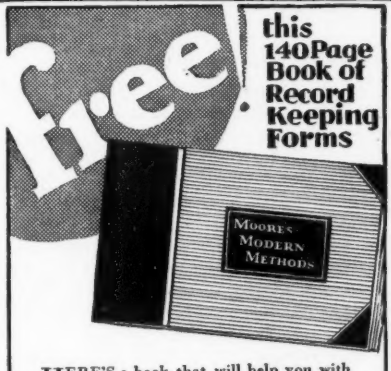

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GANDHI has been much in the limelight by reason of his civil disobedience campaign to secure Indian Independence. His mass disregard for the salt laws is front page news and when we last heard of him he was on tour in an automobile and having tire trouble in the cactus regions. Wherever he goes he spreads discontent, for he has an uncanny faculty for casting a spell by the sheer force of his personality. He is a powerful thorn in the Indian government's side but they were wise enough not to martyrize him by hurrying his arrest. We have often wondered what this Indian Moses really wants. He seemsal most as bewildered as anybody else. It is the mission of this book to try to make known the principles for which he stands, giving his thoughts and aspirations in his own words as far as possible. Gandhi is a legend, but a personified legend. The author has been with him on recent tours, therefore the information outside of Gandhi's writings is authentic. $3.15 postpaid—*A. A. H.*

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SCIENTIFIC AMERICAN

24 West 40th Street, New York City

Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

Secrecy of War-Time Inventions

GREATER secrecy for inventions useful in the national defense is proposed in the draft of a bill submitted to the House by the Acting Secretary of the Navy, Ernest Lee Jahncke, reports *The United States Daily.*

The proposed measure was prepared, he said, by the interdepartmental Patents Board as a substitute for one originally submitted by the Navy Department, and has the concurrence of representatives of the War and Navy Departments on the Patents Board.

"The efficiency and international superiority of all armament, equipment, appliances, and facilities for the Army and Navy," he added, "are of primary importance and are always the subject of first consideration on the part of the War and Navy Departments. Constant effort towards improvement and unremitting vigilance in the pursuit of it are practiced at all times by both departments.

"The only source from which the maximum of efficiency and the possibility of superiority may be hoped for is continuous invention. Of course, many inventions of military value are made in other countries and never come to light in the United States. Also many inventions that are offered to and are acquired by one or the other of the two military departments become public beforehand.

"However, a large number of valuable inventions, and sometimes fundamentally important inventions, are made by persons connected in some way with the government service and in numerous instances by patriotic citizens in private occupations, and are brought to the knowledge of one department or the other before any information concerning them becomes public. During such time as it is desirable to keep inventions secret, it is necessary that patents on them be not issued, because as soon as a patent is issued it becomes public. But for the proper protection of the government's rights in and to such inventions it is necessary that they be filed in the Patent Office with applications for patents thereon.

"While in the Patent Office, in the status of 'patent applied for,' an invention is a secret so far as the inventor and his assignee do not divulge information concerning it. In these circumstances, a legal method of maintaining for a proper time the secrecy of an invention of value to the Army or Navy is a vital need. This can be accomplished in the way that seems most feasible, all this considered, by filing applications for patents and holding back the allowable patents at the discretion of the department concerned."

Standardized Bottles

WITH the purpose of promoting exports, regulating distribution and standardizing types, the leading bottle manufacturers of Germany have formed themselves into a syndicate to be known as the German Bottle Sales Company, according to a report received in the Department of Commerce from Assistant Trade Commissioner A. Douglas Cook, at Berlin.

Both domestic and foreign sales will be handled by the syndicate. It is estimated that between 500,000,000 and 750,000,000 bottles (colored glass only) are produced annually in Germany. Exports, which before the World War amounted to about 35 percent of the output, have declined to approximately 20 percent. It is expected that the combine will be able to increase exports again.

The bottles concerned are especially beer, mineral water, wine, liqueur, and alcohol bottles. Under the new arrangements, all patented manufacturing processes will be pooled for the benefit of all members of the syndicate, thus avoiding competition between the different manufacturing processes.

British Tire Importation Decreases

BRITISH imports of rubber tires and tubes recorded a further extensive decrease (except as regards solid tires) in 1929, while exports in the same commodities, following a decline in 1928, evidenced considerable recovery, according to a report from Consul General John J. Davis, London, the Department of Commerce announced recently. The announcement follows:

Imports of pneumatic outer covers were valued in 1929 at 2,143,739 dollars, against 12,808,555 dollars in 1927; inner tubes at under 400,000 dollars contrasted with more than 1,574,000 dollars; and solid tires at 455,000 dollars, compared with upwards of 800,000 dollars, but this last-named description rose by about 10,000 dollars above the value in 1928.

The cause of the marked decrease in imports of tires and tubes, the report stated, can be traced mainly to factories for these goods having been set up by certain foreign firms, in consequence of the imposition of an import duty as from April 12, 1927.

Oil Trademark Upheld

IN the case of Vacuum Oil Company versus Walter and Company, First Assistant Commissioner Kinnan held that Walter and Company, of Rio de Janeiro, Brazil, is entitled to register, as a trademark for lubricating oils, a mark consisting of the pictorial representation of a griffin with the word "Griffin" appearing thereabove and the notation "Domina Attricto" therebelow, notwithstanding the long use by the Vacuum Oil Company of New York and registration of a mark for the same goods consisting of the pictorial representation of a gargoyle, with the word "Gargoyle" thereabove.

The ground of the decision is that these marks are not so similar that their contemporaneous use would be likely to cause confusion.

In his decision, after noting that applicant had taken no testimony and that it appeared from the opposer's evidence that it was long prior in the field and had carried on a very extensive business and consequently doubt, if it exists, must be resolved against the applicant, the First Assistant Commissioner said with respect to the marks:

"Both parties have adopted a pictorial representation of a fictitious or fanciful creature, that of the opposer being only somewhat similar to an eagle as to the body although the head is quite dissimilar to such a bird, while the griffin simulates the head and wings of an eagle with the body, feet, and tail of a lion. The similarity of the two pictorial representations is very remote. The names of such fanciful creatures are likewise wholly dissimilar in spelling, sound, appearance, and significance. Unless it be held that the opposer is entitled to such an interpretation of its trademark rights as would preclude any rival in business from using any pictorial representation of a fanciful animal, however distinct from that used by the opposer, in connection with a name of such fanciful creature, it is believed the applicant is entitled to registration of its trademark."

With respect to the testimony as to the dress of applicant's goods and certain activities in connection with their sale and the former commercial relations between the applicant and the opposer, he said:

". . . but all these matters refer to activities in another country, Brazil, and are immaterial and irrelevant to the issue to be determined in the case at bar. The opposer has alleged that the applicant has not used its mark in interstate or foreign commerce in this country, but has submitted no evidence to support such allegation and it is thought the opposer is not entitled to raise such a question in the instant proceeding."

Patents and Trademarks In Panama and China

PATENTS and trademarks, of which the certificates of registration already have been granted, must be recorded in the mercantile register of Panama regardless of whether or not the company owning the registered patents or trademarks is doing business in Panama, according to information received from Assistant Trade Commissioner Fred C. Rogers, Panama City, and published in *Commerce Reports.*

As a result of the inclusion of such matter in the office of the Secretary of Agriculture and Public Works, and according to the provisions of the Commercial Code which became effective on July 1, 1917, all factory and trademarks and patents for inventions, for which certificates of registration have been acquired since that date, must be recorded in the mercantile register.

The provisional regulations for the promotion of industrial manufactures in China, promulgated by order of the National

Government on June 18, 1928, apparently limit to persons of Chinese nationality the right to apply for and obtain patents. According to these regulations, Americans, as well as other foreigners, will be unable to protect their patent rights, for under the clauses of encouragement which are intended to promote industry only Chinese may make application for permission to exploit new inventions and industrial processes.

It is understood that this matter has been brought to the attention of the Chinese Government on behalf of American citizens in order that their rights in patents may be protected against infringement.

Centrifugal Casting Process Claims Allowed

CLAIMS defining a process for the centrifugal casting of hollow bodies of steel have been allowed by the Board of Appeals of the Patent Office, *ex parte* John Chapman Bell. The claims had been rejected on the ground that they merely set forth the obvious way of using the apparatus disclosed, or one equivalent thereto. It was pointed out by the Board of Appeals that a process of treating matter to produce a given result, and a machine suitable to perform the process, constitute distinct entities, and if new and useful, each may form the subject matter of a patent independently of the other.

The applicant stated that the essential novel features of his process lie in two manipulations. The first consists in maintaining the nozzles through which jets of metal are delivered into the rotating mold at a constant distance from the surface upon which the metal is deposited. The other consists in maintaining constant the pressure in the spout through which the metal is delivered to the mold.

While it is undoubtedly true that the mere function of a machine is not subject matter for a patent, yet it is equally true that a process consisting of certain operations upon matter to change its form or condition constitutes patentable subject matter, if new and useful. This is true, even though such an operation may be performed by an apparatus devised to practice the process and such apparatus may have no other function.

Deceptive Advertising Discontinued

THE practice of advertising a concern as occupying an entire building in the conduct of its business when it only utilizes a part of the building, creates an erroneous impression upon the public trade, according to announcement by the Federal Trade Commission, stating that an individual so advertising had signed a stipulation agreeing to discontinue the practice. The Commission's statement follows:

Manufacturing and selling toy airplanes, an individual circulated advertising matter containing illustrations of what purported to be a picture of the building in which his business was carried on.

On the front of the building, as shown in the picture, appeared in large display type the following: "World's Largest Manufacturers, Model Airplane Sets and Supplies," and over the door of what seemed to be an annex of the building appeared the words "Shipping Department."

However, the business was limited to the manufacture and sale of miniature or toy airplanes and repair parts for them. The volume did not exceed 10,000 dollars a year. The enterprise was carried on in two small rooms of the upper story of a small building and no separate space was utilized for shipping.

Signing a stipulation agreement with the Federal Trade Commission, the individual agreed to stop circulating advertising matter which tended to create the erroneous impression that he occupied all the space in the building, and which contained the representation that he was the world's largest manufacturer of model airplane sets and supplies.

(Names of individuals or firms signing stipulation agreements are not mentioned in the Commission's press releases or publications, but the facts in the proceedings are presented to show methods of competition condemned by the Commission as unfair, for the guidance of industry and protection of the public.)

"Must Sell" Must Not Be Used

TWO individuals in different parts of the country, engaged in selling and distributing diamonds in interstate commerce, signed stipulations with the Federal Trade Commission agreeing to cease and desist from use of the words "must sell" in an advertisement when there were no emergencies compelling the immediate sale of their products.

They advertised as follows: "Diamond ring. Must sell. Beautiful lady's setting. Large blue-white perfect cut diamond. For quick cash, 100 dollars."

Rural Electrification

ELECTRIC utility companies and the State administration in Ohio are cooperating in plans to extend rural electrification on a basis that will insure the widest possible use of electricity on the farms, was a recent oral statement of Governor Myers Y. Cooper, according to *The United States Daily*.

Conferences between the governor, representatives of the electric companies, the public utilities commission, the Ohio Farm Bureau Federation, and officials of the Ohio State Grange have been held on the subject and are producing results, the governor said.

One of the principal plans is to have the utilities provide lines to rural territory without cost to the farmers. Heretofore the subscribers have had to pay for the line, which in many cases made the cost prohibitive, the governor said. Further conferences are planned by the governor in which it is expected that a basis of mutual agreement will be reached.

"The administration feels that rural electrification is one of the most important social and economic benefits which possibly can be extended to the farmer and is bending every energy in bringing together a meeting of minds of the farm groups and the utilities interested on the basis of fairness and equity, making the program attractive to the farmer from the standpoint of costs."

Frozen Fresh Meat

THE rapid development of the quick-freezing process of preserving fresh-cut meats to be sold in packaged form is said to be one of the most revolutionary developments in food merchandising since the advent of canned foods, according to a recent oral statement on behalf of the foodstuffs division of the Department of Commerce.

The new system, it was said, calls for butchering the carcass promptly into individual cuts, which are frozen solid in air-tight wrappers and chilled to 50 degrees below zero. It is claimed that the quick-freezing process brings the meat to the consumer with the weight, flavor, texture, and appearance unchanged.

The present cost is about 2.45 cents per pound, which is expected to be reduced under large-scale production. Savings will be realized in the elimination of waste. Transportation savings are expected, since the space taken up by packaged meats is less, it was pointed out. (A similar method of preserving fresh fish was described in our issue of March, 1929.—*Editor.*)

Roofing Trademark Upheld

IN respect to the case of The Duro Company versus Central Paint and Roofing Company, First Assistant Commissioner Kinnan held that the Central Paint and Roofing Company of Louisville, Kentucky, is entitled to register, as a trademark for smooth surface and slate surfaced composition roofing, a mark consisting of the notation "Dur-A-Bull" and the pictorial representation of a bull, notwithstanding the prior adoption and use by The Duro

Patents Recently Issued

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Pertaining to Aeronautics

AIRPLANE—Having rotatable members operating independently of the wings, and adapted to adjustably receive air under pressure for increasing the lift, and acting as stabilizers for retarding rolling, pitching and slipping of the plane in the air. Patent 1753112. George R. Engledow.

Pertaining to Apparel

GARTER—Wherein a plurality of disengagable supporting members are connected with the shirt and hose in order to provide supports at

Company of Dayton, Ohio, of the notation "Duro" as a trademark for various goods used in connection with houses.

The ground of the decision is that the goods of the two parties are not of the same descriptive properties and the marks themselves are not deceptively similar.

In his decision, after noting that the opposition had been dismissed on the grounds above stated, the First Assistant Commissioner said, with reference to the goods:

"I am of the opinion that the decision of the acting examiner of interferences is without reversible error. Obviously the applicant's composition roofing is not of the same descriptive properties as any of the goods enumerated in the opposer's trademarks."

With reference to the marks, he said:

". . . it is equally true that the applicant's mark, consisting of the word 'Dur-A-Bull' and a pictorial representation of a bull, does not so nearly resemble the opposer's mark 'Duro' as to be likely to cause confusion or mistake in the mind of the public."

And then, after citing certain registrations to show that the term "Duro" did not originate with the opposer, he said:

"In view of the prior adoption and use by others of the word 'Duro' both as a trademark and as the whole or an essential part of the names of companies or corporations, it is believed that the opposer is not entitled to such broad protection of its mark as to exclude from registration the applicant's mark."

Type Font Patent Granted

THE Commissioner of Patents was in error in refusing to grant a design patent on a font of type known as "Cooper Black," the District Court for the District of Maryland has ruled, in ordering a decree entered requiring the issuance of the patent.

The plaintiff, in his action under section 4915 of the Revised Statutes, also sought to require the issuance of design patents on two other fonts known as "Cooper Old Style" and "Cooper Italic," but the court dismissed the action as to these, holding that it lacked jurisdiction under section 4915, as it read before the 1927 amendment, since an appeal had not been taken from the action of the Commissioner.

The question of jurisdiction was held to be governed by the statute as it stood before the amendment, since appeals were pending before the Commission when the amendment became effective. The court explained the jurisdiction under section 4915 both before and after the amendment in 1927.

A design for a font of type was held by the court to be a proper subject for a design patent. The claim for the "Cooper Black" font was not anticipated by the prior art, it was also ruled.

The court in dealing with the requisites for a design patent held that the tests of invention for such patents are the same as for mechanical patents, and there must be originality and exercise of the inventive faculty; in the former novelty and utility, in the latter novelty and beauty. In designs, it was stated, invention is measured by the appearance as an entirety when judged by the taste and fancy of an average person. The design must disclose at least a rudimentary esthetic appeal, it was pointed out.

distant points, without causing any undesirable pinching of the leg, and holding the shirt against rising. Patent 1753125. Max Lederman.

TOE-DANCING SHOE—A ballet slipper of the usual sandal type which will not pucker at the sides and is so constructed as to obviate the use of ribbon fastenings, but to draw the upper in hugging engagement with the foot. Patent 1754054. James Selva.

HEEL PAD—For use between the heel of the foot and the inside of the shoe, an inexpensive elastic cushion pad for supporting the body and relieving the jars incident to walking on hard floors. Patent 1756107. Tomizo Tanigawa.

Chemical Processes

GRANULATED PRODUCT AND PROCESS FOR MAKING SAME—A process for granulating dust resulting from the metallurgical reduction of arsenic bearing ores and material which comprises mixing said dust with sulphuric acid and water, agitating and at the same time drying the mixture. Patent 1755985. Harry C. Gardiner.

PROCESS FOR TREATING ANIMAL HAIR AND WOOL WITH CHLORINE—A process for carroting comprising applying to the hair or wool an aqueous solution of hydrogen chloride and a chlorate and oxalic acid and causing the substances to react with each other in contact with the hair and wool. Patent 1756723. Erich Bohm.

Designs

DESIGN FOR LACE—The inventor has been granted seven patents on ornamental designs for lace. Patents 80820, 21, 22, 23, 24, 25 and 80826. Ben A. Ball.

DESIGN FOR A DRESS—The inventor has been granted two patents, 80845 and 80846. Dorothy Long.

DESIGN FOR A COMBINATION AIRPLANE AND THERMOMETER—Patent 80873. Frank Alessi.

DESIGN FOR A CARTON OR SIMILAR CONTAINER—Patent 80909. Frederick W. Peterson.

DESIGN FOR A COAT—The inventor has been granted two patents for ornamental designs. Patents 80899 and 80900. Dorothy Long.

DESIGN FOR A MIRROR OR SIMILAR ARTICLE Patent 80956. Edwin B. Langsdorf.

DESIGN FOR A DRESS—The inventor has been granted two patents, 80957 and 80959. Dorothy Long.

DESIGN FOR AN ENSEMBLE SUIT—Patent 80958. Dorothy Long.

DESIGN FOR A COAT—Patent 80960. Dorothy Long.

DESIGN FOR A BRACELET OR SIMILAR ARTICLE —Patent 81019. William Reichert.

Electrical Devices

ELECTRICAL PLUG AND SOCKET—Whereby the plug when its lead or contact arms are inserted in the socket will have an engagement with the socket in a manner to prevent accidental withdrawal of the plug. Patent 1753064. William Nonnenman.

ELECTRIC MEASURING INSTRUMENT—A modified form of volt meter, for use with secondary batteries, primarily for giving indications to the driver of a motor vehicle the amount of energy in the battery at any particular time, or when recharging will be necessary. Patent 1753043. Howard Butler.

TROLLEY-WIRE SPLICE JOINT—A two piece interlocking splice for resisting longitudinal separation, is particularly useful in splicing broken wires, providing a proper electrical contact and mechanical strength, and a smooth path for the trolley wheel in passing thereover. Patent 1754991. Samuel J. Evans.

Vegetable Oil Trademark

IN the case of The Southern Cotton Oil Company versus Globe Grain and Milling Company, First Assistant Commissioner Kinnan held that Globe Grain and Milling Company of Los Angeles, California, is not entitled to register the term "Westola," as a trademark for shortening for frying and baking foods, in view of the prior adoption and long use by The Southern Cotton Oil Company of the term "Wesson" as a trademark for a vegetable-oil product used as a shortening in the same processes.

The ground of the decision is that the goods are of the same descriptive properties and the marks confusingly similar as applied thereto.

In his decision, after noting that the testimony showed long and extensive use by the opposer and therefore, doubt, if any, must be resolved against the later comer, and noting applicant's argument that since its product is normally about the consistency of lard and sold in large quantities, whereas the goods of the opposer are usually sold in liquid form and in small containers, there would be no likelihood of confusion, the First Assistant Commissioner said:

"There is some attempt on the part of the applicant to show that the opposer's goods are not used for the same purpose as are the goods of the applicant but the evidence seems fairly satisfactory that the uses of the goods of both parties very largely overlap. Even if the applicant generally sells its goods in bulk to bakers, there is nothing to restrict its activities to this class of customers, or to prevent a considerable expansion of its business in connection with small quantities of its product put up in small containers sold to a different class of customers."

"Both marks employ the initial syllable 'Wes' while the remaining portions of the marks are quite dissimilar. It may be conceded that the first syllable of the applicant's mark is 'West' but when the entire mark is pronounced it is quite likely that the second syllable would be regarded by the public as made up of the letters 'to.' The first portion of a fanciful mark is more likely to be retained in the memory of a casual purchaser or observer than the other part of the mark. It would seem there is at least some probability that purchasers would confuse the two marks since they seldom have both marks before them at the same time for comparison but decide from memory and without much reflection."

With respect to the argument that although applicant's mark had been in use since 1920, no confusion had been shown, the First Assistant Commissioner, after noting that the testimony showed that applicant's sales had largely been on the Pacific Coast and in Honolulu, that it had never advertised its goods and that applicant, prior to the adoption of its mark, was familiar with opposer's goods and trademark, said:

"In view of these facts there is no showing upon which to base a holding that the goods of the applicant have appeared to any considerable extent in the same market and in competition with the goods of the opposer. No inference can, in consequence, be drawn that had the goods been in the same market with those of the opposer for nine or ten years no confusion would have arisen and, therefore, none would be likely to arise in the future

ELECTRIC SERVICE TRAY—Whereon different electrically operated units, such as a toaster, boiler, perculator, etc., can be removably disposed on the tray and electrically connected with a source of current; the tray is composed of two parts, the upper part being washable. Patent 1755247. John S. Fielding.

Of Interest to Farmers

HARROW—Adapted for removing roots of plants from the soil by means of a plurality of ground engaging teeth carried along a horizontal path by chains operated by the usual traction wheels, stationary at will, or with movement retarded. Patent 1754103. John M. Hjermstad.

AGRICULTURAL DEVICE—A mechanism which may be used for various operations, such as seeding, discing, plowing, harrowing or cultivating, dispensing with labor ordinarily necessary, working the field backwardly and forwardly without supervision, other than starting and stopping, the operations being automatic. Patent 1755247. John S. Fielding.

FEED GRINDER—Having a plurality of concentric rows of teeth projecting from oppositely disposed plates, movable in an inter-fitted relation so that the feed passing between the teeth will be thoroughly ground and ejected at the plate periphery. Patent 1755037. Tom Tamen.

Of General Interest

SHIP'S PILOT LADDER—A foldable portable ladder, the steps having roughened surfaces, and being of durable construction, consisting of but few parts which are interchangeable and readily assembled without requiring the employment of skilled labor. Patent 1753060. Andrew Myerstuen.

DISAPPEARING LAWN SPRINKLER—A casing, with water actuated means for raising the nozzle into operative position above the ground and automatic means for lowering the nozzle and closing the upper end of the casing to prevent manipulation by unauthorized persons. Patent 1751723. Charles A. Borgeson.

ADJUSTABLE TOP FOR TYPE CABINETS—As used by compositors, consisting of a separate top above the type draws, and means for vertically raising and securing the top, at any desired elevation in accordance with the height of the user. Patent 1753048. Merritt W. Haynes.

REFRIGERATION COIL—With the tubes so arranged and spaced as to prevent icing of the coils to such an extent that the plant must be shut down long enough to defrost the coils. Patent 1753042. Charles M. Brenner.

MOVABLE CAMERA SUPPORT—Comprising a frame or platform, constructed to encircle a column, mechanism for raising or lowering the platform, a camera mounted thereon and adapted to move in spiral convolutions for taking pictures of the column surface. Patent 1751774. William L. Trullinger.

PHONOGRAPH CONSTRUCTION—Provided with novel means for reproducing a plurality of tones in unison but from separate sound reproducing units. As for example a separate sound reproducing unit for each member of a quartet. Patent 1752357. Hugo Wiener.

CROCHET NEEDLE—Having the usual hook at one end, but a needle point at the other, instead of being blunt, thus permitting other forms of work, a zig zag portion between the ends preventing slipping or turning over in use. Patent 1751796. Charlotte I. Denaer.

POWDER PUFF—The back of which is formed of a plurality of members suitably joined, with a handle extending from the center and secured by novel means, the face-contacting surface having no out-stitching, thereby avoiding any roughness. Patent 1754090. Leonard Friedberg.

MATCH PACKAGE—Wherein a single or double arrangement of matches may be carried and the matches properly protected, while permitting the ready removal at any time and the ignition of the match as it is removed. Patent 1754036. Roman A. Novinsky and Edward O. Barton.

COMPASS—A marine compass, including a bowl, two liquids of different specific gravity, and a compass card having turning movement, and located approximately at the line of junction of the liquids, said card being supported solely by the liquid of heavier specific gravity. Patent 1754055. Frank G. Senter.

EGG RACK—Or shelf provided with a plurality of openings for supporting eggs in spaced relation and constructed to occupy a minimum of space, may be in "dead space" yet clearly exposed to view the articles carried. Patent 1754020. Albert J. Hyde.

WINDOW CONSTRUCTION—Wherein means are provided by which each sash may be completely reversed into the room, for cleaning or reglazing, without removing outside screen or the like, adapted for use with standard window sashes and frames. Patent 1754316. Fred Hamilton.

CAMERA ATTACHMENT FOR MAKING ARTIFICIAL REFLECTIONS—By means of an angularly disposed reflecting surface in a hood, attached to the end of the lens barrel, on which the object to be photographed is reflected, giving the impression of the mirror effect of still water. Patent 1755036. Jacob H. Sussman.

UMBRELLA GUARD—In the form of a permutation locking device, connecting the staff and canopy of an umbrella, and locking the same, whereby the opening of the umbrella by all others than the rightful owner will be prevented. Patent 1755039. Harold M. Vandenhove.

TILE-ROOF CLOSURE—An interlocking metal plate which is easily applied to the lower end of a slanting roof, to fill the usual openings of standard tiles, and thus prevent the inconvenience caused by birds roosting under the corrugations. Patent 1752593. John Giordano.

SEWING WIRE FOR FLAT ROPE—A composite sewing strand or lacing for metal rope composed of hard and soft wires, the soft wires being positioned outside the hard wires, to protect them from cutting contact with the strands of the rope when in use. Patent 1755018. Richard Nitsch.

BASEMENT CIRCULATOR—A hose nozzle which may be lowered into and suspended in the hold of a ship, or basement, for fighting a fire, the water being thrown from the nozzle in an apron-like spray, substantially at right angles. Patent 1753686. Charles A. Borgeson.

SAFETY APPARATUS FOR OIL-STORAGE TANKS—A fire extinguishing apparatus for preventing the oil from being ignited by lightning, by drawing off and condensing the vapors which arise in the air space above the oil, also providing an emergency steam pipe as a last resort. Patent 1753401. Henry J. Bucking.

MILK-CONTAINER HOLDER—For tapering paper milk bottles, the construction being such that when the handles are grasped part of the holder will grip the container and hold the same against movement while being tilted or carried. Patent 1755335. Max Roman.

MERCHANDISE PACKAGE AND DISPLAY RACK THEREFOR—In which a number of packages may be associated with the rack in such a manner as to require the tearing of the package to effect its release, whereby to thwart pilfering, particularly adapted for displaying handkerchiefs. Patent 1755927. Louis N. Levinsohn.

WINDOW-CLEANING DEVICE—A thin flat pad of absorbent material adapted to contain a washing fluid, together with a handle member detachably connected, which obviates the necessity of leaning out when cleaning the outer surfaces of the window panes. Patent 1755881. John J. Kilbride.

DEMONSTRATION DEVICE—An educational apparatus for symbolically representing certain allegorical passages of the Bible descriptive of some of the views and visions of certain of the prophets, the primary purpose being for use in Sunday schools and similar assemblies. Patent 1755952. Charlie Gant.

CITRUS FRUIT JUICE EXTRACTOR—Which is manually operated, extremely simple in construction and in which the parts are so assembled that they may be removed for cleaning and oiling, the device is compact and durable. Patent 1754591. Guy B. Baker.

HUMIDISTAT—Adapted to supply water to any evaporating medium to maintain proper humidity in the air in a room or house, the device is provided with novel means for automatically regulating and indicating the humidity. Patent 1755276. Roy B. Somers.

GLOVE - DRYING RACK — Whereon rubber gloves used in hospitals, or other places, may be quickly and thoroughly dried inside and outside after each washing, all the fingers being held open with the closed ends extending upwardly. Patent 1755902. Salvatore Tascarella.

SCALE AND ATTACHMENT FOR REDUCING AND ENLARGING CAMERAS—Wherein means are provided whereby the scale and associated parts may be adjusted to take care of any slight variation in the focal length of the lens used, without being made especially therefor. Patent 1755177. Arthur Fruwirth.

ANIMAL TRAP—More particularly a trap for catching rats, which operates automatically by the weight of the animal as it enters, killing and removing the prey, and re-setting itself, ready for the next victim. Patent 1755947. Walter G. Baker.

NONSPILLABLE CONTAINER—An automatic closure for a glass or container for liquid, which will permit the contents to be poured therein, or withdrawn therefrom, while preventing spilling if accidentally tilted, or during transportation, thus preventing soiling of clothes, etc. Patent 1756249. Solomon Kaufman.

KEY CASE—Of the type having individual key holders connected with a carrier plate, the latter being attached to a flexible and foldable cover adapted to enclose the keys and render each key conveniently accessible when the cover is opened. Patent 1756627. Joseph Brewer.

HANDLE-ADJUSTING MEANS—For connecting a handle with a brush head by means of a threaded hole, and permitting the handle to be readily swung laterally at various angles, spring pressure securing the handle assemblage to the base. Patent 1756801. Charles S. Trippeda and Anthony J. Dichiaro.

Hardware and Tools

REGULATOR FOR WINDOWS AND DOORS—A rotatably mounted shaft, particularly adapted for use with outwardly opening casement windows having inside screens, whereby the window may be readily opened or closed from within the room, without moving the screen. Patent 1751718. Eric Sodergren.

ROTARY CORE-DRILL ATTACHMENT—Employing a greatly simplified gyroscopic element which will operate to determine the exact direction in which an inclined stratum of earth dips, so that the crest of an anticline may be determined by a series of drilling operations. Patent 1751678. Arthur L. Armentrout and Elwin B. Hall.

BLADE HOLDER AND HANDLE—For safety razor blades, formed from a single sheet of metal providing a pair of arms defining blade clamping jaws, so constructed that pressure effects a limited separation to allow the removal or insertion of the blades. Patent 1753459. James A. Gafney.

WIRE SPLICERS—Specially constructed for carrying out wire-splicing operations quickly and easily, and which is especially useful for splicing the ends of fence wires closely arranged with respect to each other. Patent 1754023. Sidney J. Jones.

DRAW-PUNCH—By means of which holes may be cut into sheet metal of any thickness, is especially adapted for electrical work for cutting holes in metal boxes, or for cutting in places where little room is available. Patent 1754568. John C. Nischan.

Heating and Lighting

INCINERATOR—Wherein articles may be dropped from above into the oven, while a blast of air acting as a damper, prevents gas or smoke from escaping through the opening by which articles are fed to the furnace. Patent 1755027. Aatto P. Saha.

Household Utilities

COMBINATION STOOL, LADDER AND KITCHEN BLOCK—Comprising a stool about the proper height for working at a kitchen sink, a step-ladder higher than an ordinary kitchen chair, and the top forming a meat block adapted for conveniently chopping or cutting meat. Patent 1753372. Richard G. Gober.

CARD TABLE—Composed entirely of metal, having hollow legs constituting ash receptacles, the corners of the table having depressions and openings registering with the hollow leg tops, the depressions being convenient for the support of glasses. Patent 1756777. Frederic E. Wright.

Machines and Mechanical Devices

FLOTATION MACHINE—Whereby the pulp is thrown in the form of a film or attenuated condition into a gaseous medium for maximum aerating effect, producing flotation with a minimum of energy and a maximum of aeration. Patent 1752434. Albert L. Howard.

GUIDE DEVICE—Which may be readily installed in position on the pump rod of a windmill to maintain the same accurately in line and thereby reduce loss of power by eliminating undue friction and wear. Patent 1753126. Arthur L. Ligon.

SEWING-MACHINE THREADER—An attachment for sewing machines comprising a swingably mounted bar, having a semi-conically shaped end formed of a pair of spring-pressed members which provides a guide for the thread to the eye of the needle. Patent 1753114. Allan McC. Fluharty.

APPARATUS FOR THE REDUCTION OF IMPURITIES CONTAMINATING MOLTEN METAL—Comprising an open vessel formed of a metal shell and a refractory lining, in which the improvement of the metal, by the reduction of certain impurities, is brought about by forcing air upwardly through the molden charge. Patent 1753891. Llewellyn Jones.

DEVICE FOR EXPANDING AND MOUNTING PISTON RINGS—Whereby piston rings may be expanded, and positioned in expanded condition in juxtaposition to their piston groove, into which they may be forced by hand, breakage through over-strain being practically eliminated. Patent 1755044. Kenneth J. Bailey.

BAGLE-FORMING MACHINE—Which receives a batch of dough, forms the same into strips, cuts it into sections, and rolls the sections into rings, ready for cooking, the entire treatment being automatic, without the dough touching the operator's hands. Patent 1755921. Louis Gendler.

METHODS OF PITTING FRUIT—A machine particularly adapted for pitting dates, having in view the removal of the pit from the fruit without unduly mutilating the fruit, as well as insuring precision and reliability in operation. Patent 1755872. Anthony Gotelli.

GRINDING MACHINE—Characterized by a novel form of means whereby the grinding elements and the holder thereof may be readily adjusted to the proper size for grinding worn engine cylinders of varying bore diameters. Patent 1755862. Alvin R. Berck.

BELT REPLACER—Which may be readily handled by a single operator for replacing a belt on a pulley, and operated from an advantageous position without danger from the usual revolving shafts and pulleys, and without stopping the machinery. Patent 1755876. Frank L. and Wilson R. Homstead.

FRUIT PITTER—Which will sever the flesh from the stones of peaches, apricots, etc., the flesh being cut into two halves, and removed from the stone, which is held while the flesh is severed therefrom and then automatically released. Patent 1754636. Alvan B. McCollom.

APPARATUS FOR APPLYING A SOFT-METAL SURFACING TO HARD-METAL PLATES—By flowing said substance while in a fluid molten state onto the plate over a heating medium, while automatically smoothing off the coating substance to a uniform thickness prior to cooling off the medium. Patent 1756739. August Gunthard.

Medical and Surgical Devices

BIPROXIMAL TOOTH AND INTERLOCKING KEY—A substitute for the natural tooth, and device for attaching the substitute tooth or teeth to any of the recognized abutments, characterized by the fact that it can be used in fixed or removable bridgework and dentures. Patent 1753644. Fred E. Burden.

Musical Devices

METHOD OF AND APPARATUS FOR EMPLOYING TUNING FORKS TO GENERATE AUDIO FREQUENCY CURRENT AS A MEDIUM FOR SOUND—A musical instrument, a tuning fork, and an electromagnet positioned in space relation between the prongs, an electro-mechanical sound reproducer and means for amplifying the current in a suitable form of telephone or loud speaker. Patent 1753069. Max Schumm.

Prime Movers and Their Accessories

PISTON FOR INTERNAL-COMBUSTION ENGINES—Consisting of a metal having a great coefficient of expansion, and cross members of a metal having a small coefficient of expansion fitted at one end into the peripheral part of the piston thereby eliminating danger of gripping. Patent 1756884. Charles Schaeffer.

Pertaining to Recreation

BOXING GLOVE—Constructed with a novel form of grip which is disposed within the glove permitting an unobstructed palm portion, thereby obviating danger of injury such as would be occasioned by grips protruding beyond the palm surface of the glove. Patent 1752977. Frank Dieterle.

FISH LURE—Constructed of such material as to be always bright and shiny, having the proper balance and weight to be useful for trolling or casting, and when used in casting will not be unduly impeded by the resistance of wind. Patent 1755047. Chester A. Braidwood.

FISHING GEAR—In which one or more attractors, in combination with a sinker, are disposed slidably relative to a fish hook, so that the attractors will freely recede from the hook when the fish is hooked, thereby facilitating landing. Patent 1754567. Gwendolan Newell.

DOG-RACING APPARATUS—Wherein a mechanical rabbit is caused to travel around a track and maintain its position ahead of a pack of dogs, a novel form of trap being provided for the ultimate disappearance of the rabbit. Patent 1755676. William R. Twiford and George Oehler.

AMUSEMENT DEVICE—A combination merry-go-round and see-saw which may be conveniently used on play grounds or beaches, whereby a plurality of persons may oscillate or see-saw and at the same time revolve about a vertical axis. Patent 1756854. August de Freitas.

Pertaining to Vehicles

COLLAPSIBLE KIDDY CAR—In which the supporting legs and steering handle can be folded into substantially parallel position with respect to the seat, when collapsed will take up very little room, and may be shipped in a small container. Patent 1751765. Thomas G. Shannon.

HOOD LEDGE PLATE AND MULTIPLE-COMPARTMENT HOOD FOR AUTOMOBILES—Whereby a large percentage of the space not reserved for the machinery, may be formed with separate compartments for storage purposes, yet the hood may be reduced in weight and at the same time strengthened. Patent 1754086. Earl Feilcke.

APPARATUS FOR MEASURING AND INDICATING EFFICIENCIES—Having means whereby the operator of an automobile or aeroplane, may know the speed at which his machine has the highest efficiency, whereby he may become aware of the best adjustments, and the best fuel suited for the machine. Patent 1754039. Otto A. Pawlick and Raymond C. Giese.

RELEASING COUPLING—For use in connection with pulling vehicles, such as tractors, and drawn vehicles, such as plows, for releasing the plow should it encounter a rock or other obstruction, to avert injury or breaking of parts. Patent 1754048. Fred W. Reimold.

CLUTCH-PROTECTING DEVICE—An attachment designed to protect a clutch mechanism from undue wear and tear, incident to the habit of "riding the clutch pedal," which causes the clutch parts to wear unnaturally, the attachment is capable of being easily installed. Patent 1755002. Charles M. Hibbets.

SPRING BOOT—Comprising a sheet of flexible and liquid-proof material constituting a liner, adapted to embrace a spring, for the protection, retention of lubricants, and permanent preservation against deterioration by exposure to the elements. Patent 1753257. Alfred R. Ulp.

VEHICLE SPRING—Which permits greater vertical play, adds to the length of the working wheel base, transmits less vibration, prevents distortion of the frame, counteracts momentum in rounding corners, and can be adjusted to meet varying loads. Patent 1753420. Joseph N. Johnson.

AUTOMOBILE RADIATOR CAP—Having an outwardly-closing, inwardly-opening valve which permits the filling, or addition of water to the cooling system, without the necessity of removing the cap, thereby eliminating the danger of scalding or injury to the car finish. Patent 1755316. Francisco O. de Alcocer.

BERRY-PICKER'S VEHICLE—An argicultural machine whereon a number of persons may be drawn over a berry patch supported in a convenient leaning seated position, with their hands free to pick berries, and their backs relieved of strain. Patent 1756803. Jacob D. W. Williams.

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